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Annotated bibliography contains 365 references related to the behavioral and physiological effects of noise. References to research articles, texts, other literature reviews and symposia are provided. The review covers the period 1968 thru 1974. Some foreign research published as early as 1966 is reported. The review is subdivided into approximately twenty relevant areas including personality differences, sleep, sonic boom, noise measurement, effects of noise on social relevant behavior, hearing loss, temporary threshold shift, physiological effects, motor skills, vigilance and perceptual processes.

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BEHAVIORAL AND PHYSIOLOGICAL CORRELATES OF VARYING NOISE ENVIRONMENTS: ANNOTATED BIBLIOGRAPHY

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ABSTRACT

Annotated bibliography contains 565 references related to the behavioral and physiological effects of noise. References to research articles, texts, other literature reviews and symposia are provided. The review covers the period 1968 thru 1974. Some foreign research published as early as 1966 is reported. The review is subdivided into approximately twenty relevant areas including personality differences, sleep, sonic boom, noise measurement, effects of noise on socially relevant behavior, hearing loss, temporary threshold shift, physiological effects, motor skills, vigilance and perceptual processes.

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INTRODUCTION

The purpose of this bibliography is to provide the contractor (EPA) and interested researchers with an update of noise effects with respect to both behavioral and physiological variables. The bibliographers do not guarantee the quality of the research nor is this annotated bibliography to be construed as a critical review of the literature. It is intended as a compilation of research, in some twenty areas, published since 1968. These areas are represented by 365 bibliographic citations. The entire bibliography is preceeded by a broad overview intended to convey the general findings. Each sub area is preceded by a specific overview intended to present the essence of the research findings for that area. The casual reader should find adequate coverage thru reading of the general and specific overviews. The practicing researcher may wish to pursue a specific topic by critical reading of the pertinent abstracts and by securing a copy of the original paper.

As in all efforts to provide literature reviews, the bibliographers found it necessary to exclude certain areas. We did not do so capriciously but only with the intent of limiting the review to articles directly or peripherally related to the behavioral and physiological effects of noise. Additionally there was no attempt to survey the "world's" literature. We generally included articles which were abstracted in psychological abstracts or were available thru the Defense Documentation Center.

Those interested in obtaining articles held by the Army Foreign Science and Technology Center, Charlottesville, Virginia should note that these articles are limited in distribution to agencies of the United States Government only. Requests from other agencies must be referred to:

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OVERVIEW

Research on industrial noise seems aimed at demonstrating its adverse consequences. Findings indicate discomfort, irritation, emotional crises and a persistent neurotic symptomatology. Autonomic dysfunction, hypertension and ulcers occur more frequently among persons exposed to noise levels above 85 dB. Research results with respect to community annoyance and aircraft operations indicate that smaller aircraft operating in larger numbers may help alleviate the annoyance.

Research in the area of Temporary Threshold Shift (TTS) and permanent hearing loss indicates that the potential costs to industry from noise are greater than for any other occupational disease. Even newborn infants are exposed to noise levels which approach damage risk criteria.

The findings relative to the effects of noise on learning and cognition are inconsistent. Some researchers note facilitating effects while others report decrements in performance. This appears to be time and intensity specific. In addition there are sex, age and socioeconomic differences in performance under noise environments.

In most areas, both developmental and individual differences are apparent. Evidence indicates that crying infants quiet more easily when exposed to auditory stimulations. Additionally, older subjects (60 years) performed more poorly in both noise and no noise environments. Middle class elementary students perform at lower levels in a white noise or home noise environment compared to lower class children.

There appears to be an interaction with respect to the task involved and the noise environment for motor skills tasks. White noise appears to have a detrimental effect while continuous noise actually enhanced psychomotor performance for skilled subjects. Further, task difficulty and the pace at which tasks are to performed result in decrements in performance. Asymetrical presentation of intermittent noise affects equilibrium to a greater extent than either variable alone while free field noise has greater effects than similar noise presented through headphones. Noise has been implicated in long term learning effects in that students who learned to type in quiet conditions performed better than those who learned in a noise environment. These differences were observed 60 days after the learning sessions.

Socially relevant behaviors can be affected by noise. In a noise environment, tolerance for ambiguity decreases, anxiety increases and perception of others assumes negative dimensions. Further, frustration tolerance decreases following stimulation with unpredictable noise. Although the organism may physiologically adapt, there appears to be a psychological cost of noise exposure.

Personality variables have been shown to moderate changes in performance in a noise environment. For example, extroverts are more prone to noise distraction and display greater physiological arousal than introverts. Also, the increasing loudness of a noise stimulus augments subjective annoyance, with neurotic personality traits contributing to the synergistic effect. Additionally, speakers judged to be angry seem to use more high frequency elements in their speech while scores of "Test Anxiety" are positively correlated with judged loudness.

The physiological effects of noise stimuli have been the subject of a number of studies. One researcher concludes that medical evidence clearly shows autonomic habituation to noise does not occur. Experiments with both human and infra human subjects indicate that noise affects blood circulation, metabolism, and the pituitary-adrenal cortex system. Increases in urinary catecholamines, free fatty acids and adrenal weights have been reported. Reductions occur in blood eosinophil, concentration of adrenal catecholamines and resistance to acute hypoxia. Further, pulse amplitude decreases, skin blood content increases and heart rate increases. One Soviet study reports lasting disturbances in the blood brain barrier permeability to macromolecular phosphoric compounds due to noise exposure.

In general, no major disruption of sleep patterns are reported for subjects experiencing sonic booms, but some changes in EEG sleep patterns in response to white noise are reported. REM compensation seems to occur on quiet nights following noisy nights. There are contradictory data with respect to the effects of sonic booms. This may be due to a failure to differentiate between startle responses which tend to hamper performance and orienting responses which enhance performance.

Speech disfluency, especially misarticulation of consonants appears to be related to noise masking. Facilitative effects of noise with stutterers are noted. Release of stuttering blocks has been observed when using high frequency, narrow band masking.

The effects of noise on vigilance tasks continues to be an area of wide research interest. Some researchers show vigilance performance decrements while others show differential effects depending on vigilance task difficulty. One study indicates that subjects perform a vigilance task better when the information is presented in both the visual and auditory sense modes.

SPECIFIC NOISE SOURCES

AIRCRAFT AND INDUSTRIAL NOISE EFFECTS

With relatively few studies reported since 1970, the primary research efforts have concentrated on demonstrating the adverse consequences of noisy industries, as well as those different from industries, traditionally the subject of legislative protection such as the watch making industry (Stancari, 1967).

Documentation of noise induced trauma include: Angeleri's (1966) finding of discomfort and irritation while noise persisted, emotional crises that occurred at the end of work and a persistent neurotic symptomatology, latent or obvious; Jansen's (1971) findings of autonomic dysfunction appearing more frequently among noise exposed workers; and Jirkova's (1971) observations indicating that impairment of hearing, subjective difficulties, hypertension and ulcers occurs more frequently among persons exposed to noise levels above 85 dB. Also, Cohen (1972) found that the more obtrusive the noise and the more demanding the task, the greater is the likelihood of adverse effects of noise on task performance. With regard to aircraft noise, Johnston (1972) found that as long as the background noise level is increased less than 10 dB, community annoyance grows imperceptibly with the number of similar operations, leading to a recommendation for smaller aircraft operating in larger numbers. Mabry, (1973) has demonstrated a reliable laboratory technique for measuring the effective perceived noise level (EPNL) and Stockbridge (1973) has developed methods to judge the psycho-social consequences of aircraft noise.

Angeleri, Franco, & Cocuzza, Carlo. The effects of noise on the nervous system: a clinical and electroencephalographic study on forty workers exposed to industrial noise for many years. Annali di Neurologia e Psichiatria, 1966, 60(4), 257-81.

Fifty percent of 19-64 year old industrial workers, exposed an average of 15 years to varying noise levels (95-112 db) and frequencies

(300-9600 Hz), revealed 3 basic disturbances, occurring singly, but mostly in combinations: (1) discomfort and irritation while the noise persisted, (2) emotional crises that reoccurred at the end of work, and (3) a persistant neurotic symptomatology, latent or obvious. The disturbances directly attributable to the noise were regarded as the expression of special underlying reactivity associated with miopragia of the CNS. The similarities between disturbances directly due to intense noise and the condition of latent or clear neuroses were stressed. The chronological dependency that characterized the relationship between certain behaviur disorders and noise levels prompted a hypothesis centered on culmulative affects and the critical release of emotional tension.

Chocholle, R. & Augustynska, D. Some preliminary experiments on the reduction of noise by dephasing. Journal de Psychologie Normale et Pathologique, 1969, 66(3), 261-279.

This research attempted to determine whether the use of an auxiliary sound source dephased at 180. would reduce the sound or noise emitted from another sound source. The procedure was to regulate sounds emitted from 2 loudspeakers of the same intensity but in opposite phase at a certain point in space. Results indicate that an important reduction of acoustical pressure was registered at the point of the control. However, this was actually only in a very limited zone around this point. The reduction thus obtained disappeared quickly as one moved away from this point.

Cohen, Harris, H. Working efficiency as a function of noise level, work pace, and time at work. Dissertation Abstracts International, 1972, 33(8-B), 3976.

A review of the literature shows that the more obtrusive the noise and the more demanding the task, the greater is the likelihood of adverse effects of noise on task performance. A study was conducted which varied three levels of task speed or work pace (30,40 and 50 signals/min) on a paced, serial repetitive task requiring complete and sustained attention under two conditions of aperiodic broadband noise, quiet (50 dB(A)) and noise (100 dB(A)). One hour work periods were broken down for analysis into four 15 minute time blocks.

The experimental hypotheses were confirmed. Namely, (1) noise adversely affected performance on a paced, serial repetitive task; (2) the faster the work pace, the poorer was performance (3) noise more adversely affected performance at fast work paces than at slower work paces; and (4) performance in noise at fast work paces deteriorated disproportionately with time at work. The practical, as well as the theoretical, implications of the research are discussed.

Jansen, Gerd.*On the origin of autonomic dysfunctions through the action of noise. Army Foreign Science and Technology Center Charlottesville, Va., 1971, Report No. FSTC-HT-23-237-71.

One thousand and five workers from factories of the German metallurgical industry were examined medically and psychologically in order to be able to demonstrate the genesis of autonomic dysfunctions as an effect of noise. Six hundred and sixty-nine workers were employed in factories where an intense noise influence was prevalent.

Jirkova, Hana & Kremarova, Bohumila. Investigations of the effect of noise on the general health of the workers in large engineering works. Army Foreign Science and Technology Center Charlottesville, Va., 1971, Report No. FSTC-HT-23-273-71.

The investigation concerned 969 persons, using records obtained from factory physicians. It dealt with the occurrence of overall morbidity and especially with the occurrence of hypertension, ulcers, impairment of hearing, neuroses, and subjective difficulties at noisy work centers (with noise level higher than 85 dB).

The results of observations indicate that impairment of hearing, subjective difficulties, hypertension, and ulcers occur more frequently among persons exposed to noise. On the other hand, the data presented did not demonstrate that a noisy environment would result in a higher number of neuroses, nor did it demonstrate that the frequency of the diseases under study, with the exception of impairment of hearing, it is related to the length of employment.

Johnston, G. W. V/stol community annoyance due to noise: proposed indices and levels for Toronto-York transportation committee. *Toronto University Institute for Aerospace Studies*, 1972, Report No. UTIAS-TN-177.

Distinctive features of V/stol versus conventional aircraft are noted. Currently popular methods for assessing conventional aircraft noise (CNR and NEF, on this continent) are shown to be much less appropriate for V/stol. Both speech interference and perceived noise annoyances have been included in parallel. Robinson's noise pollution index is especially well suited to the evaluation of the total perceived noise annoynace since background noise effects are included directly. "A" weighted sound level is adequate for initial assessment of speech interference annoynace. Maximum v/stol levels for these indices, in urban residential districts of L sub npmax = 75 (PNDB) and L sub Nmax = 80 (PNDB) are proposed. Perceived noise contours (L SUB NP) calculated adjacent to a hypothetical Toronto waterfront stolport site confirm that when the aircraft noise exceeds the background by 10 dB or less, community annoyance grows imperceptibly with the number of similar operations flown. Smaller aircraft operating in larger numbers, to fulfill a given transportation task, therefore offer a substantial annoyance improvement over larger similar technology aircraft.

Mabry, J.E. & Parry, H.J. An evaluation of psychoacoustic procedures for determining human noise: Volume II. Demonstrated examples. *Society of Automotive Engineers Inc. New York*, 1973, Report No. SAE-A-12-2.

A variety of laboratory procedures have been used to measure human response to aircraft noise during the development of the effective perceived noise level (EPNL) concept. Evaluation of these procedurus to determine their effectiveness would be useful in further refinements of EPNL. This report describes a project to demonstrate how four of the laboratory methods can be tested and the results used to provide a comparative evaluation. The general conclusion is that experimental plans for four basic psychoacoustic laboratory methods have been demonstrated.

Mabry, J.E. & Parry, H.J. An evaluation of psychoacoustic procedures for determining human response to aircraft noise. Volume I. Specifications for four experiments. *Society of Automotive Engineers Inc. New York,* 1973, Report No. SAE-R-12-1.

Absence of good agreement among laboratory studies involving human response to aircraft noise led to the conclusion that the application of different psychoacoustic procedures could account for differing requirement to develop an engineering calculation procedure which validly reflects response to flyover noise from future aircraft (Stol, Vtol, sst), A three-phase program was conceptualized. The document deals with phase 1: detailing of specifications and requirements for four psychoacoustic laboratory experiments plus the acquisition of tape recordings of noises that match the four experiments.

Kosa, D. & Lampe, I. *Pneumatization of the mastoid process in individuals working under conditions of excessive noise. *Army Foreign Science and Technology Center Charlottesville Va.*, 1971, Report No. FSTC-HT-23-244-71.

The degree of pneumatization of the mastoid process was tested in 70 workers who had been working under conditions of excessive noise for at least ten years, all of whom exhibited hearing loss due to noise. X-rays were made according to the Schuller technique showed no connection between the degree of pneumatization of the mastoid process and the development of noise damage. There was no difference in the average reduction of individuals with good and poor pneumatization of the mastoid process.

Maksimiva, L. I. Changes in hearing of workers under a prolonged effect of noise with standard parameters. *Foreign Technology Division Wright-Patterson AFB Ohio,* 1974, Report No. FTD-HT-23-1036-74.

For prolonged periods of time, under industrial conditions, noise, at 85-88 dB (which is at the maximum permissible levels) in the frequency range of 800 to 4000 HZ, can present a danger with regard to the development of occupational hardness of hearing when the individual's hearing organ is not sufficiently stable. In order to improve the effective standards, in addition to physiological studies, it is necessary to carry out dynamic clinical observations in the process of chronic noise effect under industrial conditions.

Stancari, Vittorio; Gherardi, Gabriele & Sardo, Gabriello. Noise and acoustic trauma in the processing of watch jewels. *Securitas*, 1967, 52(12), 43-56.

To study acoustic trauma in noisy industries different from those traditionally the subject of legislative protection, phonometric and audiometric research was conducted in a factory where synthetic jewels for the watchmaking industry were being processed. The spectral phonometric analysis permitted the demonstration of a noise level that is harmful, particularly in the department where holes are made in the jewels by means of electric drilling. Conversely, the audiometric tonal analysis showed that all of the 52 *S*s examined, and particularly those directly concerned with the drilling, were suffering from signs of a cochleopathy of the acoustic trauma type, and this was the case even with *S*s who had worked in the factory for comparatively short risks and the harm connected with acoustic trauma, and should be considered when the proposed revision of the legislation relating to insurance against professional ear troubles is undertaken in Italy.

Stockbridge, H.C. & Lee, Mary. The psycho-social consequences of aircraft noise. *Applied Ergonomics*, 1973, 4(1), 44-45.

The investigation describes and compares methods including social surveys, analysis of complaints, and direct observation of investigating the social disamenity caused by aircraft noise. Effects of aircraft noise are discussed, and it is concluded that technologists can and will decrease engine noise levels if social pressure continues to be applied.

SONIC BOOM

The first two articles in this section are reviews of animal and human responses to sonic booms. The remaining reports deal with two primary sets of responses: startle responses and orienting responses.

The literature on the behavioral effects of sonic boom appear to be contradictory. On the one hand, facilitation of behavioral tasks is observed (e.g. Thackray et al, 1971), while on the other hand, decrements in performance are seen (e.g., Lips, 1972). In those studies where decrements are observed, there appears to be a direct relationship between intensity of the boom and impairment.

Thackray (1972) suggests that the apparent lack of consistency in studies on behavioral effects of sonic booms may be due to a failure to differentiate between the startle responses and the orienting responses. The former tends to hamper performance and the latter to enhance it. He proposes objective criteria for distinguishing between the two response patterns.

Bell, Wilson B. Animal response to sonic booms. Journal of the Acoustical Society of America, 1972, 51(2, Pt. 3), 758-765.

Reports and studies of animal response to sonic booms are reviewed. Specific reactions to sonic booms differ according to the species involved, whether the animal is alone, and perhaps whether there has been previous exposure. Reactions vary and are not predictable. Sonic boom reactions of several species are described with considerable detail on the reactions of mink.

von Gierke H. E. & Nixon, C. W. Human response to sonic boom in the laboratory and the community. Journal of the Acoustical Society of America, 1972, 51(2, Pt.3), 766-782.

This report discusses the loudness and annoyance of individual booms and their dependence on the boom overpressure and pressure-time functions as well as the complex reaction of individuals, groups, and communities exposed to sonic booms of varied magnitude and frequency. The few experiments available proving that even sonic booms of the maximum intensity presently feasible do not produce direct medical injury are described. Based on the integrated body of results of recent physiological, psychoacoustic, behavioral, and sociological studies in various countries, estimates of the effects and acceptability of regular, frequent supersonic commercial overland flight schedules are presented and discussed in terms of aircraft noise pollution in general, and of the potential certification of aircraft with respect to noise and sonic boom. Findings support the current policy that commercial supsonic transport aircraft will not be permitted to fly over the United States unless and until the noise factors are brought within acceptable limits.

Lips, K.W. An unstable steering task with a sonic-boom disturbance. *Toronto University (Ontario) Institute for Aerospace Studies*, 1972, Report No. UTIAS-TN-179.

An initial study was made concerning the effect of sonic boom disturbances on an individual's compensatory tracking performance for an unstable system. In certain respects the tracking task simulated automobile driving. It was found that most individuals were disturbed and recovered in varying degrees.

Rylander, Ragner, Sorensen, Stefan, Berglund, Kenneth, & Brodin, Carina. Experiments on the effect of sonic-boom exposure on humans. *Journal of the Acoustical Society of America*, 1972, 51(2, Pt. 3), 790-798.

This research reports the results of a field experiment in Sweden studying boom exposure effect on structures. Military aircraft flew over a test area generating sonic booms of various intensities. Thirty-three 20-53 yr. old females and 165 military recruits were exposed directly under the flight path, the exposure effect being measured with the aid of a visual performance and a tracking test. In addition, the subjective reactions of *S*s present at other sites under the sonic-boom carpet were evaluated with the aid of a questionnaire.

Thackray, Richard I., Touchstone, R. Mark & Jones, Karen N. The effects of simulated sonic booms on tracking performance and autonomic response. *FAA Office of Aviation Medicine*. Report No. 71-29, 1971.

Forty *S*s were exposed to simulated (indoor) sonic overpressure levels (outdoors) of 1, 2 and 4/square feet during 30 minute periods of compensatory tracking. Four booms were presented during each period. Following booms, performance improved, skin conductance decreased, and heart rate decelerated; the pattern suggested an orienting response rather than a startle reflex. However, rise times of the simulated booms were longer (6-27 msec) than those of true booms, and this factor may have contributed to the obtained performance and physiological effects.

Thackray, Richard I., Rylander, Ragnar & Touchstone, R. Mark. Sonic boom startle effects-- Report of a field study. *Civil Aeromedical Institute Oklahoma City Okla.*, 1973, 20 pages.

The study reports the results of a sonic boom field study conducted in Sweden during October 1972. Ten female subjects were tested indoors on each of six days. Two age groups were studied: 20-35 and 50-65 years. Fighter aircraft flying at various heights over the test site produced booms with outdoor overpressures ranging from 60-640 N/Sq. M. The number of booms extended from 5 to 13 per day. Subjects performed indoors on an arm-hand steadiness task. The results indicated that outdoor overpressures ranging from 70-120 N/Sq. M.(26-35 N/sq. M. indoors) produced reflexive arm-hand movements in about 10 per cent of the subjects. Booms of 300 N/sq. M. (67 N/sq. M. indoors) and greater produced responses in about 75 percent of the subjects, between these extremes of overpressure there was the suggestion of a critical overpressure range lying between 150-180 N/sq. M. (40-46 N/sq. M. indoors) in which an abrupt increase in startle response occurred.

Thackray, Richard I., Touchstone, Robert M. & Bailey, Joe P. A comparison of the startle effects resulting from exposure to two levels of simulated sonic booms. *Federal Aviation Administration Washington, D.C. Office of Aviation Medicine*, 1973, Report No. FAA-AM-73-16.

Subjects were exposed indoors to simulated sonic booms having outside overpressures of 50 and 150 N/sq. M. Rise times were held constant at 5.5 msecs. In addition to the outside measurements, inside measures of dBlin and dDa were also obtained. Subjects attempted to hold a hand-steadiness device on target during boom exposure and amplitude of the arm-hand startle response was determined. Recordings were also obtained of the skin conductance and heart-rate responses as well as the eye-blink reflex. Although the 50 N/sq M. boom produced slight arm-hand startle responses in a small percentage of subjects, the frequency of these responses was significantly greater to the higher boom level. Tentative conclusions advanced that sonic booms experienced indoors may cause slight arm-hand startle responses which could have adverse effects on occupational tasks in which arm-hand steadiness is the principal skill required, but that it seems unlikely these responses would significantly impair performance on less sensitive psychomotor tasks.

MULTIPLE STRESSORS

With respect to noise as an independent variable, a casual review of the literature indicates, with few exceptions, that noise is treated as a unitary influence and little attention is focused on the potential interactive effects of noise with other stressors. The exceptions to this research set are noteworthy. For example, the detrimental effect of noise is additive to that of vibration when both are presented simultaneously (Harris and Schoenberger, 1970). Using heat, noise and vibration, Grether (1972) failed to find combined effects which produced more severe performance decrements than the most severe single stressor (heat stress). In a later confirmatory study using additional physiological response measures, the same combination of stressors produced no additive effects and the greatest impairment in performance was vibration alone, (Grether, Harris, Ohlbaum, Sampson and Guignard, 1972). Using noise and neomycin, Jauhiainen, Kohonenaud and Jauhiainen, 1972, demonstrated a synergistic effect. The harmful effects were shown to increase more than predicted by the simple addition of the two effects. Campbell (1968) showed that noise plus shock were more aversive than shock or noise alone and concluded that aversive drives resulting from these stressors summated.

Campbell, Byron A. Interaction of aversive stimuli: Summation or inhibition ? Journal of Experimental Psychology, 1968, 78(2, Pt. 1), 181-190.

This research attempted to determine the manner in which 2 aversive stimuli, noise and shock, combined to influence behavior. Exp. I and II with 40 and 768 male Sprague-Dawley rats, respectively, showed that an irrelevant, inescapable electric shock masked the reinforcing properties of noise reduction. Exp. III with 40 male Sprague-Dawley rats demonstrated that the aversive properties of noise and shock summated, i.e., noise plus shock were more aversive than shock alone. Results demonstrated that aversive drives summated and the reinforcement was proportional of the relative reduction in total aversiveness.

Grether, Walter F. Two experiments on the effects of combined heat, noise and vibration stress. *Aerospace Medical Research Lab Wright Patterson AFB Ohio*, 1972, Report No. AMRL-TR-71-113.

Operational flying often exposes crew members to combinations of environmental stresses that may affect flight personnel differently than would be predicted from single-stress laboratory experiments. To obtain a better understanding of such combined-stress effects a major experiment was conducted using heat (120F), noise (105 dB) and vibration (5 Hz, 0.30 peak G), both singly and in combination. Measurements were made of tracking ability, choice reaction time, voice communication, mental arithmetic, visual acuity, body temperature, heart rate, weight loss, and subjective ratings of the stress. On none of these measures did the combined triple stress-condition produce greater effects than did the most severe single stress. The physiological measures only heat stress produced significant effects, and the addition of noise and vibration produced no further effects. On the performance measures, particularly the tracking test, impairment was slightly less for the triple-stress condition than for vibration only. Thus there were no additive interactions, and in fact some evidence of antagonistic interactions.

Grether, W.F., Harris, C.S., Ohlbaum, M. Sampson, P.A., Guignard, J. Further study of combined heat, noise and vibration stress. *Aerospace Medical Research Lab Wright Patterson AFB Ohio*, 1972, Report No. AMRL-TR 71-131.

In an earlier study a combination of heat, noise and vibration stress had no greater, and for some measures slightly less, effect on physiological and performance functions than did the same levels of heat or vibration alone. As a follow-up on that finding, this study used the same levels of heat (120 F), noise (105 dB) and vibration (5 Hz, 0.30 peak G), but with some modifications of the earlier experiment. Physiological measures included skin and rectal temperature, heart rate, weight loss and biochemical urine analysis. Performance measures included two-dimensional compensatory tracking, choise reaction time, a voice communication test of logical alternatives, mental arithmetic, visual acuity and subjective ratings of the stress conditions. The combination of stresses produced no additive stress interactions. On tracking and reaction time tests the greatest impairment of performance was produced by vibration alone. Subject ratings of stress severity progressively increased with the number of stresses in the combination. Subjective ratings of stress intrusiveness, however did not show such a trend.

Guignard, J. C. & King, P.F. Aeromedical aspects of vibration and noise. Advisory Group for Aerospace Research and Development Paris France 1972, Report No. AGARD-AG-151.

Vibration and noise are treated separately in parts one and two of this volume; while part three deals with the special aeromedical problem of auditory perception in aircrew and ground support personnel and its conservation. Part four is a glossary of relevant terms. This division of the subject matter recognizes that in practice vibration and noise are conveniently studied, measured and controlled as separate entities. It should, however, be borne in mind that these conditions rarely affect man singly. They are commonly present at the same time; and vibration and noise may often be associated with different kinds of environmental agents, such as heat, to make up a combined environmental stress.

Harris, C. & Schoenberger, Richard W. Combined effects of noise and vibration on psychomotor performance. USAF AMRL Technical Report, 1970, 70-14, 24 p.

Tracking performance and RT of highly trained Ss to the appearance of a red light and disappearance of a green light were measured during four experimental conditions: 2 conditions of 85- and 110-dB broad-band noise exposure, and 2 in which these noise exposures were combined with .25g vertical vibration at 5 Hz. Duration of exposure for each condition was 19 min. Vibration had an adverse effect on both the horizontal and vertical dimensions of the tracking task and on RT to both sets of lights. Noise had a significant effect, both with and without vibration, but only on the vertical part of the tracking task. On vertical tracking, the detrimental effect of noise was additive to that of vibration when both noise and vibration were presented simultaneously (110-db noise and .25g vertical vibration at 5 Hz).

Jauhiainen, T., Kohonen, A., & Jauhiainen, Merja. Combined effect of noise and neomycin on the cochlea. Acta Oto-Laryngologica, 1972, 73(5), 387-390.

The combined harmful effect of intensive noise and neomycin on the cochlea were studied in 3 groups of guinea pigs; one receiving neomycin alone (n = 8), One exposed to noise alone (n = 10), and one exposed to both factors (n = 8). Electrophysiologically and microscopically, the harmful effects were shown when the 2 factors were combined, to increase more than predicted by simple addition of the 2 effects. The correlation between the percantage of destroyed outer cells and the microphonic potential amplitude loss was calculated. It is suggested that there may be greater susceptibility to noise-induced hearing loss in patients treated with ototoxic antibiotics.

Renshaw, Frank Marvin. The combined effects of heat and noise on work performance. (Doctoral dissertation, University of Cinncinnati) Ann Arbor Mich.: University Microfilms, 1972, No. 73-3842.

Twelve male subjects performed at a Five-Choice Serial Reaction Task under environmental conditions of heat alone, noise alone, and heat in combination with noise. The study was divided into two exposure phases, a single stress phase and a multiple-stress phase. Subjects in the single-stress phase experienced four levels of either heat or noise. The multiple stress phase consisted of both single and combined exposures to different levels of heat and noise. The four levels of heat used in the study were: E.T. 72°F., E.T. 78°F., E.T. 84°F., and E.T. 90°F. The four levels of noise were : 41 dBA, 80 dBA, 90 dBA, and 100 dBA. All exposure sessions were 1-1/2 hours in length with the performance task occupying the final thirty minutes of each session. The measures of performance analyzed in the experiment included total responses, total errors, relative errors, and gaps in response. Each measure was statistically treated by analysis of variance techniques. Performance change was predicted from the Arousal Theory which proposes and inverted "U" -shaped relationship between environmental stimulation and performance. Improved performance is anticipated as either heat or noise is raised from a low to a moderate level; however, further increase in environmental stimulation, either by raising one factor from a moderate to a high level or by combining factors, will result in performance degradation. The results indicated a detrimental effect of heat on gap scores. Subjects showed 18 percent more gaps at E.T. 90^{0}F. than E.T 72^{0}F. A detrimental effect of noise was noted in the case of total response scores. Subjects made 5 percent fewer responses at 90 dBA than at 41 dBA. Both gap scores and relative error scores revealed an interaction between the effects of moderate heat and moderate noise. Support for the Arousal Theory was only evident under multiple stress conditions suggesting that only combined stresses were truly over-arousing. Individual stress variations were insufficient to display meaningful performance change. Only gap scores followed predictions based on the Arousal Theory: more gaps occurring under multiple-stress conditions than under single-stress conditions. An alternative explanation for alterations in gap scores based on Bills' theory of mental blocking could also account for these findings.

Scull, John. Effects of shock and noise on running after training with partial or continuous reward. *Psychonomic Science,* 1971,23(5), 325-326.

Forty male Wistar albino rats were given partial or continuous reward in a runway, continuous reward while either shock or loud noise was presented early in the runway on 1/2 of the trials, and finally extinction. Shock produced conditioned suppression in the segment preceding its administration, a decrement in running immediately following it., and an increase in running speed in the last segment. Noise did not produce conditioned suppression but did produce an increase in speed following its administration. Partial reinforcement did not alter any of the effects of either stimulus, but reliably increased resistance to extinction.

Wilkinson, Robert. Some factors influencing the effect of environmental stressors upon performance. *Psychological Bulletin,*1970, 72(4), 260-72.

Six factors were distinguished in the working situation influencing the effect of environmental stress upon performance; (1) the duration of work in the task, (2) the familiarity of the operator with the stress and with the work he has to do under stress, (3) the level of incentive of the operator, (4) the kind of work he has to do, (5) the aspect of performance which is most important, and (6) the presence of other stresses in the working situation. The examples taken to illustrate the importance of these factors come from only four stresses: heat, loss of sleep, noisem and alcohol.

Wyon, D.P. Studies of children under imposed noise and heat stress. Ergonomics, 1970, 13, 598-612.

This paper assesses moderate stress research as a field of study in which principles governing the choice of criteria of stress and strain are reviewed. Important parameters of moderate stress research are identified and placed in the context of an empirical scheme, with reference to which their interpretation and relevance are discussed. Studies by the author of 11, 13 - and 17 - year old children under imposed heat stress are used to illustrate the scheme and are interpreted in terms of arousal and effort. An approach to the study of noise in the moderate stress region is suggested in which measures based on sound pressure level are unlikely to have much relevance. This view is supported by preliminary results from a study of 10-12 year olds under intermittent low-level noise.

NOISE EFFECTS

AUDITORY DISCRIMINATION AND PERCEPTION

A large body of research literature exists regarding human auditory performance and perceptual abilities. Primarily, this knowledge can be categorized into the following areas:

1. Duration Discrimination - Abel (1972) found that duration discrimination is not frequency dependent between 200-3500 Hz and Rochester (1971) found the process of signal detection (in noise) and duration discrimination to be very similar. Evidence comes from Hawke's (1970) work with helicopter vibration and time perception that indicates support for the notion of a psychobiologic clock as the key mechanism in determining time perception of noise.

2. Frequency Discrimination - Most research concentrates on detection of pitch changes in various types of noise. Mulligan (1970) shows that frequency bandwidth is directly dependent on S/N ratio. Maximum sensitivity to pitch appears between 2200 and 2300 Hz at low S/N ratios. Richards (1969) further demonstrates that when the masking noise is held constant, pitch shift increases with frequency. This is supported by Lovell (1971) with findings of upward pitch shifts using white noise and negative pitch shifts using pink noise. Other work in this area includes Moss's (1970), "Short-term Recognition of Memory of Tones"; Gebhart's (1972), "Frequency Discrimination and MLD"; Jesteadt's (1969), "Frequency Discrimination Near Masked Thresholds"; and Canahl's (1970), "Binaural Masking of a Tone by a Tone Plus Noise".

3. Intensity Discrimination - Several studies investigate Weber's Law using monkeys (Clopton, 1972) and human subjects. Vienmeister (1972), has investigated intensity discrimination of pulsed tones. Generally, Weber's Law holds for a large range of background intensities but not for pulsed tones. One interesting study by Vienmeister (1970) provides evidence that decisions involving intensity discrimination are made based on an observed input and a "noisy" stored reference. Other studies

center on binaural versus monaural summation of loudness. Scharf (1970) substantiates that binaural summation does occur over an intensity range from 40-110 dB (SPL) with a ratio of from 1.6 to 1.85 that increases with SPL. Davies (1970) found that when judging the intensity of white noise versus shadowed words, most subjects judged 90 dB shadowed words to be louder than 90 to 115 dB noise, lending support for Treisman's filter-amplitude theory of attentional selection. Additional subjective evaluations of noise show that with the use of 5 point scales ranging from very quiet to intolerably noisy, subjects tend to give most measured levels of ambient noise a subjective "moderately noisy" rating (Weber 1971). The area of intensity discrimination has been also investigated by Melamed (1971), Goldberg (1972), and Pinheiro (1971).

4. Localization of Sound Source - Harris (1971) finds that much usable directionality exists in the monaural mode of hearing. The duration of the stimulus in facilitating localization for low frequencies is important and also for front-to-back localization, with longer durations allowing more time for head movements (Thurlow, 1970). Additional work done in this area by Jeffress (1971) indicates that substantial individual differences exist in the relative importance of time and intensity cues used by subjects in the detection and lateralization of a sound source. Other investigators in this area are: Tonnimg, McFadden, and Hafter.

5. Signal Detection In Noise - Several investigators have looked at the perception of "click-thresholds and intensity discrimination". Since click stimuli have virtually no energy variations, stimulus-oriented theories of detection and discrimination cannot be used to explain why click intensity discrimination is improved by the addition of background noise (Raab, 1969). This effect is evident even in the detection of two-click thresholds where the addition of a steady background noise produces a remarkedly small change in the magnitude of the threshold (Leshowitz, 1971). Other research in this area is by Dolan, Feth, Irwin and Young.

6. Response to Noise (Infants and Children) - Several investigators have looked at audio discrimination in infants and children. It appears

that children (median age 7) can detect auditory signals presented against a continuous background of noise about as well as adults --- showing differential selection as a function of frequency (Greenburg, 1970). Other studies center on methods to improve infant auditory testing using alternated stimuli to reduce response decrements (Ling, 1971) as well as determining the effect of various audio stimuli on infants. Haverstein (1969) found that generally, intensity must be from 25 dB above adult threshold for voice, to 72 dB for a 4000 Hz stimulus. Voice generally results in the largest percentage of responses for all age groups (3 and 8 month old). Broadband spectrums also generate more responses than those of limited bandwidth (Mendel, 1971). Also, auditory stimulation generally quiets crying babies more readily than non-stimulation Bench, 1969).

7. Noise Effects and Children's Classroom Performance - Nober (1973) demonstrates that auditory perception is adversely affected by noise in the environment; therefore, children's auditory testing should be conducted in a noise environment to be a valid index within the normal classroom setting. This finding is further supported by Powers (1971) who found that in a noise environment, retarded readers show a significant (.005 level) decrement in mean auditory discrimination. However, there is no auditory difference between cerebral palsied and neurologically unimpaired children (Griffin, 1971).

B. Interaction and Perceptual Effects of Noise:

a. Visual and Ocular Performance

Smith (1970 found that an acoustic signal administered before completion of the adaptive afterimage process will cause prolongation of the adaptive process and some defensive reactions. Intermittent noise also affects visual search tasks similar to actual work situations (Warner, 1970). Additional findings show that the eye and ear behave as independent sensors presenting both a discrete decision and a measure of confidence to the decision system (Corcoran, 1969). Interestingly, ocular responses (eye movements) only occur in a rotating sound stimulus condition (McFarland, 1969).

b. Distraction Effects of Noise

Fisher (1974) found that noise bursts cause localized distraction effects on a serial response bias in yes-no detection with gated noise and simultaneously gated signal plus noise and found both sequential and probability contrast effects dependent on the stability of the judgmental frame of reference provided by the continuous noise.

c. Sex Effects

Kumar (1969) found that with female subjects, noise had a facilitating effect on a mechanical task with no deterioration in performance on a mental task contrasted to male deterioration on both.

d. Effects of Noise on "Sonar Doppler Discrimination and Auditory Adaptation" were investigated by Smith (1971) and Synder (1971). Results show a significant interaction between noise level and sensation level required to maintain pitch discrimination thresholds. Frequency discrimination was not related to noise level.

e. Influence of White Noise on the Reversibility of the Necker Cube.

Letourneau (1971) found reversibility to be lowered with a sound of 1,024 Hz at 80 and 90 dB.

9. Interaction and Perceptual Effects of Light Stimuli on Audio Discrimination and Perception.

a. Melamed (1970) found that bright lights enhanced judgments of intensity of soft tones, but Bothe (1970) found no consistent effect of auxiliary visual stimulation on absolute auditory sensitivity for subjects examined in the dark with sound-synchronized flashes of different intensity light.

Abel, Sharon M. Duration discrimination of noise and tone bursts. Journal of the Acoustical Society of America, 1972, 51,(4, Pt. 2), 1219-1223.

The human O's ability to discriminate a difference in duration was investigated for noise bursts and gated sinusoids. Two undergraduate O's compared 2 durations T and T + DELTAT in a 2-alternative forced-choice procedure. The value of T ranged from .16 to 960 msec. For each T the value of DELTAT for 75% discrimination was determined. Results show that for most of the range investigated DELTAT was proportional to T1/2. Performance was not affected by a change in bandwidth from 3,500-200 Hz. Values of DELTAT for 75% correct did decrease, however, when the O's were given audible spectral cues from very short pulsed sinusoids. The theory best describing the results was the neural counter model proposed by C. Creelman.

Ahumada, Al & Lovell, John. Stimulus features in signal detection. Journal of the Acoustical Society of America, 1971, 49(6, Pt. 2), 1751-1756.

Short bursts of computer-generated Gaussian noise were rated by O's for the presence or absence of a 500-Hz signal tone burst in 2 experiments with 17 undergraduates and young faculty members. A multiple regression analysis found for each O the linear combination of the energies in narrow bands around the tone frequency that best predicted his total ratings. The estimates of the regression coefficients provided graphs of the frequency responses of the O's. Most of the reliable variance in the total ratings was accounted for by the regression analysis in terms of energy in narrow bands. Differences among O's are explained in terms of differential weighting by Os of features labeled "tone presence," "pitch," and "loudness."

Bench, John. Some effects of audio-frequency stimulation on the crying baby. Journal of Auditory Research, 1969, 9(2), 122-8.

Two experiments are described in which crying babies were stimulated by pure tones and noise bands of one minute duration. The babies generally quieted more readily when exposed to auditory stimulation than when unstimulated. The effectiveness of the sound stimulus was in inverse relation to frequency. Differential masking effects, tactile artifact, and an innate pitch discrimination or preference are considered as explanatory hypotheses.

Blegvade, B. Bekesy Tracings in normal listeners following contralateral masking. *Acto Oto-Laryngologica*. 1968, 65(4) 349-57.

Bekesy fixed-frequency tracings for continuous tones were studied in normal listeners before and after masking the contralateral ear with wide-band noise of low and moderate intensity. The effect of contralateral masking persisted beyond the masking period, and the effect was more pronounced after the threshold drifts being observed. A weak masking of one ear was regularly followed by tinnitus in the opposite ear exclusively.

Bothe, Gary G. & Marks, Lawrence E. Absolute sensitivity to white noise under auxiliary visual stimulation. *Perception & Psychophysics*, 1970, 8(3), 176-178.

Absolute sensitivity to white noise was measured with *O* in the dark, in constant illumination, and in the dark but with sound-synchronized flashes of light at three different intensities. A confidence rating procedure was used, and results were analyzed in terms of the theory of signal detectibility. There appeared to be no consistent effect of auxiliary visual stimulation on absolute auditory sensitivity for the four O's examined.

Canahl, Julius A. Binaural masking of a tone by a tone plus noise. *Journal of the Acoustical Society of America*, 1970, 47(2, Pt. 2), 476-479.

It was hypothesized that the release from masking observed when noise is masking a tone signal would be affected by the addition of a tone masker. If the level of the tone masker is increased to a high enough value, there should be no release from masking. Results of the study with 3 normal hearing *S*s show that a pure-tone masker does reduce the size of the magnitude of the release from masking as a function of the level of the masking tone, but not to *0* as was predicted. The effect was found to be differential with respect to the phase of the tone masker and is explained in terms of the interaural correlation of the total masker waveform. Some evidence is presented that indicates release from masking occurs when a tone is used to mask another tone.

Clopton, Ben M. Behavioral and neural aspects of increment detection by monkeys for the intensity of wide-band Gaussian noise. *Dissertation Abstracts International*, 1970, 31(2-B), 540.

Clopton, Ben M. Detection of increments in noise intensity by monkeys. *Journal of the Experimental Analysis of Behavior*, 1972, 17(3), 473-481.

Three male rhesus monkeys were trained to detect 100-msec increments in intensity of continuous white noise. A response on 1 or 2 bars was reinforced if it conformed to the presence or absence of the increment on that trial. Stimulus parameters of background intensity, increment size, and probability of increment presentation were varied and response probabilities and latencies recorded. Data analysis within the context of signal-detection theory revealed response biasing toward 1 bar or the other to be related to probability of increment presentation, whereas sensitivity depended on combination of increment size and background noise intensity. Weber's law held for a large range of background intensities since sensitivity to relative intensity increments varied little.

Corcoran, D. W. & Weening, D. L. On the combination of evidence from the eye and ear. *Ergonomics*, 1969, 12(3), 383-394.

Four signals varying in frequency and beat-rate were presented for identification in noise over an oscilloscope (V), over earphones (A), or over both systems simultaneously (AV). Four models were used to predict AV performance from performances on A and V. The most successful model assumed that the eye and ear behave as independent *O*'s, that the sensors present both a discrete decision and a measure of confidence to the decision system, that the certainty is proportional to the probability of the discrete decision, and that an optimal weighting of certainties occurs in conflict between A and V. Reasons for divergencies between bimodal word recognition and detection studies are discussed.

Davies, D. R. & Chapman, A. J. Relative loudness judgments of material presented dichotically. Psychonomic Science, 1970, 19(4), 216-217.

Three groups of 12 undergraduates listened to white noise of 80, 90, or 115 dB. presented to one ear, while they shadowed words presented at an intensity of 90 dB. to the other ear. Subsequently, Ss judged whether the noise or the speech was louder or if they were of the same intensity. All 12 Ss judged 90-dB shadowed speech to be louder than 80-dB noise, 11 Ss judged 90-dB shadowed speech to be louder than 90-dB noise, and 8 Ss judged 90-dB shadowed speech to be louder than 115-dB noise. Results support A. M. Treisman's filter-amplitude theory of attentional selection.

Dolan, Terrence R. & Trahiotis, Constantine. Binaural interaction in backward masking. Perception & Psychophysics, 1972, 11(1-B), 92-94.

The advantages of the binaural auditory system over the monaural system were described when detecting a tonal signal in a background of masking noise. These advantages are referred to as masking-level differences (MLDS). It has been demonstrated that performance in detecting a tonal signal that has been reversed in phase at one ear relative to the other ear is about 15-17 dB. better than detection of the same signal in-phase at the 2 ears when masked by moderately intense masking noise, i.e., in-phase at the 2 ears. The explanations for this phenomenon fall into 2 general categories, and both types of explanations are based upon the interaction of the tonal signal and masker when they are added together. Data are presented which indicate that an MLD of at least 4-6 dB. can be obtained in a binaural masking experiment in which the offset of the tonal signal precedes the onset of the noise masker.

Dorosh, M. E. Tong, J. E. & Boissonneault, D. R. White noise, instructions, and two-flash fusion with two signal-detection procedures. Psychonomic Science, 1970, 20(2), 98-99.

Two signal-detection procedures were used to parcel out the effects of white noise and instructions with a 2-flash discrimination task. Neither condition influenced the sensitivity scores of either model. Variations in instructions changed the criterion and threshold measures. High correlation coefficients were obtained for the corresponding scores of the 2 signal-detection analyses.

Elfner, L. F. Continuity in alternately sounded tone and noise signals in a free field. Journal of the Acoustical Society of America, 1969, 46(4, Pt. 2), 914-917.

Two experiments are reported that employed 10 normally hearing listeners who demonstrated an ability to concentrate on an interrupted white noise that alternated with a tonal burst to demonstrate continuity effects in a free-field situation and to investigate the effects of frequency and level of the signal component, the duration of the noise component and the angular separation of the 2 components. Results show that the level and the duration variables effected changes in the perception of continuity in the noise.

Feth, Lawrence L. Auditory signal detection in non-Gaussian noise. Dissertation Abstracts International, 1970, 30(9-B), 4391.

Fisher, Shirley. A "distraction effect" of noise bursts. Perception, 1972, 1(2), 223-236.

The effects of 2-sec, 80 dB noise bursts on a 5-choice serial response task were investigated using 18-26 year old enlisted naval ratings. A localized effect of noise burst onset was reported. This effect was confined to the distribution of first responses, following noise burst onset but not offset, and occurred on only a proportion of trials. Detailed analysis of the occurrence of the brief delays suggests that there was no systematic occurrence, that the information processing stage of the on-going serial response might be important, and, finally, that distraction and not paralysis provided a better description of the mechanism of the effect.

Gabhardt, Carol J., Goldstein, David P. & Robertson, Ronald M. Frequency discrimination and the MLD. *Journal of the Acoustical Society of America*, 1972, 51(4, Pt. 2), 1228-1232

Binaural frequency difference limens were obtained in noise under homophasic and antiphasic conditions. Signal frequencies of 200, 300, 500, 700, and 1000 Hz. were investigated at 5-and 10 dB sensation levuls while 500 Hz was also explored at 15, 20, and 25 dB. The masker was a band-limited noise with a spectrum level of 55 dB. Results with 4 normal hearing adults indicate significant changes in discrimination behavior as a function of phase condition and sensation level. Alternative interpretations of the data are considered.

Goldberg, Israel A. Auditory intensity discrimination with bursts of reproducible noise. *Dissertation Abstracts International*, 1972, 32(8-A), 4888-4889.

Greenberg, Gordon Z., Bray, Norman W. & Beasley, Daniel S. Children's frequency-selective detection of signals in noise. *Perception & Psychophysics*, 1970, 8(3), 173-175.

Five children, median age 7 yr., and 6 adults, median age 20 yr., served as *O*'s in a task requiring the detection of auditory signals presented against a continuous background of noise. Two alternative, temporal-forced-choice trials of 5-sec duration were presented periodically in blocks of 50 during 2 or 3 1-hr sessions. During a block, some 70% of the signals were of 1000 Hz. and approximately 30% were probe signals of a frequncy other than 1000 Hz. After only rudimentary description of the task, *S*s performed adequately. Results from children and adults were similar, showing differential detection as a function of signal frequency. The demonstrated frequency selection is consistent with a sensory-filter model of *O*'s auditory behavior.

Griffin, Kathleen Mary Fleming. Certain auditory perceptual abilities in selected cerebral palsied children. (Doctoral dissertation, University of Oregon) Ann Arbor, Mich.: University Microfilms, 1971, No. 72-927.

This investigation was an attempt to determine whether or not cerebral palsied children differ from normal children in auditory perceptual abilities. Literature concerning neurologically impaired children indicates that cerebral palsied children may be inferior to neurologically unimpaired children in performance on auditory perceptual tests, especially when such tests are presented in a background of noise.

The hypotheses were stated in the null form: (1) cerebral palsied children do not differ from neurologically unimpaired children in performances on auditory perceptual tasks; (2) children at any one age level do not differ from children at another age level in performance on auditory perceptual tasks; (3) the children do not differ in performances on auditory perceptual tasks under three acoustic conditions; and (4) cerebral palsied children do not differ from neurologically unimpaired children in performances on auditory perceptual tasks in background noise.

The experimental group was composed of 24 cerebral palsied children, six at each of the following age levels: eight, nine, ten and eleven years. All children had intelligence levels and bilateral hearing levels within normal limits; they also had intelligible speech and attended an elementary school. A control group of 24 neurologically unimpaired children of similar age levels, intelligence quotients and schools was selected.

Eight linguistic tests of auditory perception in three areas -- auditory verbal memory, auditory verbal sequencing and auditory verbal discrimination -- were administered to the subjects by means of a tape recorder. The tests were presented under three acoustic conditions: in quiet, in a background of cafeteria noise at a signal-to-noise ratio of 30 dB and in a background of cafeteria noise at a signal-to-noise ratio of 5 dB.

The Principal Components Analysis procedure and an analysis of variance were used in processing the data: The major findings were:

1. The cerebral palsied children as a group did not differ significantly from the neurologically unimpaired group in performances on auditory perceptual tasks.

2. A significant difference as a function of age level was found in the performances of the cerebral palsied children and the neurologically unimpaired children collectively; the performance of the eleven year olds was superior to the performances of children at the the three younger age levels.

3. The interaction between age and group was not significant; the cerebral palsied children and the neurologically unimpaired children performed in a similar manner at all four age levels.

4. No significant differences were found in the performances of the cerebral palsied children and the neurologically unimpaired children as a function of acoustic condition. Apparently, neither presence nor absence of background noise had a significant effect on the performances of the subjects of this study.

5. The cerebral palsied children did not differ significantly from the neurologically unimpaired children in performances on the auditory perceptual tasks as a function of acoustic condition. The performances of the cerebral palsied children were not affected by the background noise to a significantly greater degree than those of the neurologically unimpaired children.

It was concluded that a general deficit in auditory perception does not exist in cerebral palsied children, although certain subgroups of cerebral palsied children, such as those with low intelligence levels, hearing impairments or linguistic deficits, may have auditory perceptual problems. This investigation supports the use of auditory verbal instruction for cerebral palsied children, at least for those with the characteristics of the sample in this study. It does not support the notion that presence of auditory background noise interferes with the ability of cerebral palsied children to perceive auditory events.

Gusev, E. K. Microinterval analysis of binaural hearing. *Voprosy Psikhologii*, 1969, 15(6), 36-48.

Investigated the effect of separating the arrival of 2 tones, 1 at each ear, by 1-5 msec. on binaural masking, loudness, and detectability of the tones. It is suggested that the interaction of central effects occurs in 3 stages: reciprocal sensory equilibrium, transitional, and facilitation; the 1st 10 msec. of interaction being phasic, the rest tonic.

Hafter, Ervin R., Bourbon, Walter T., Blocker, Anne S. & Tucker, Ann. A direct comparison between lateralization and detection under conditions of antiphasic masking. *Journal of the Acoustical Society of America*, 1969, 46(6, Pt. 2), 1452-1457.

Four Ss (2 of the authors and 2 naive Ss) were instructed to indicate the lateral displacement of signals presented at 5 levels of signal-to-noise ratio. Signals were 500-Hz 100-msec bursts of tone heard in a wide-band noise mask. A likelihood ratio analysis of lateralization data allowed a direct comparison between detection based on lateralized differences and detection obtained in a standard 2-interval forced-choice detection experiment. It was found that the measure of detection based on lateralization is nearly the same as that actually obtained in the conventional detection experiment.

Harris, J. Donald & Sergeant, Russell L. Monaural/binaural minimum audible angles for a moving sound source. *Journal of Speech & Hearing Research*, 1971, 14(3), 618-629.

Papers on monaural localization relating to the action of the vestibular apparatus, influence of the auricle, and movements of the head were reviewed. To test one conclusion of the review, that a *moving* sound source should yield a continuous set of changing loudness/phase/timing cues available to the ear, an experiment was conducted which provides more complete quantification of monaural/binaural comparison. Minimum audible angles (MAA) were computed from the responses of 3 men, highly experienced in listening, to white noise and tones produced by a moving sound source. Ss listened (a) with both ears open, and 0 and 60 azimuth (az.) were as good as the binaural MAA for white noise, and for the lowest tone at 0. az., but distinctly inferior elsewhere. Both az. and monaural/binaural mode effects reached high significance statistically. Data show much usable directionality for the monaural mode.

Haversten, G.H. & Moncur, J.P. Stimuli and intensity factors in testing infants. *Journal of Speech & Hearing Research*, 1969, 12, 687-702.

Sound stimuli at each of four sound levels were randomly administered to 21 three month old and 22 eight month old infants. Pulsed white noise, pulsed 500 Hz, pulsed 4000-Hz, pulsed voice, and music stimuli were presented in a sound field through equi-distant loudspeakers via tape. Behavioral changes were recorded by 20 Ss. As predicted, percentage of response increased with increased sound level. In order to reach the 50% point of response, sound levels varying from 23 dB. (voice stimulus) to 72 dB. (4000-Hz stimulus) above normal adult threshold were necessary. Voice generally resulted in the largest percentage of responses for both age groups at each hearing level. The three month old infants generally gave fewer responses than the eight month old infants at comparable hearing levels.

Hawkes, Glenn R. & Worsham, Robert W. Time perception for helicopter vibration and noise patterns. *Journal of Psychology*, 1970, 76(1), 71-77.

Judgments of stimulus duration for noise and for vibration for stimuli ranging from .5-5 sec. were studied. Two methods were used, production and reproduction, with either noise or quiet backgrounds. Eight male undergraduates served as Ss. No significant effects were found for kind of stimulation or for background condition. A consistent significant effect of method was reported, a finding interpreted as supporting the notion of a psychobiologic clock. Durations tended to be underestimated with the production method and overestimated with the reproduction method. The findings may be applicable to the task of the helicopter pilot or to others involving relatively intense stimulus environments.

Hellman, Rhona P. Asymmetry of masking between noise and tone. *Perception & Psychophysics*, 1972, 11(3), 241-246.

A pure tone was used to mask narrow and wide bands of noise centered on the frequency of the tone. Four to six listeners participated in each experimental series. In an experimental session, the SPL of the tone was held constant and loudness balances were obtained between a masked and unmasked noise band of equal width. Results are compared to earlier measures of the partial masking of tone by noise. The comparison shows that noise masks a tone more effectively than the tone masks the noise. Although the effect of the tone on a critical band of noise is greater than its effect on either an octave or wide-band noise, it is considerably smaller than the effect of the noise on the tone. Decreasing the noise bandwidth still further to a subcritical width reduces the asymmetry of masking somewhat, but a difference at high intensities of about 20 dB. between masking effects of an equally intense noise and tone remains. Whether the masker is a tone or noise, masking ceases when the effective energy of the masked and masking stimuli is the same.

Higenbottam, J. & Spreen, O. Perceptual asymmetry with dichotically presented click-sentence stimuli. *Journal of Auditory Research*, 1970, 10(2), 164-175.

Three experiments were conducted on college students to determine the effect of manipulation of presentation laterality on perception of click location within sentences, each composed of six 2-syllable words. Manipulation of stimulus configuration laterality by headphone or tape channel reversal produced no differences in direction of click localization in Exp. I. Increasing task difficulty in Exp. II and III demonstrated localization differences associated with headphone reversal, although in Exp. III these differences only approached significance. Results are interpreted as an indication of perceptual asymmetry related to right-hemisphere dominance in tasks involving the recognition of sequential order.

Irwin, R. J. & Terman, Michael. Detection of brief tones in noise by rats. *Journal of the Experimental Analysis of Behavior*, 1970, 13(2), 135-143.

Two albino Charles River rats were trained to detect brief 8000-Hz tones centered in a 1/3 octave band of noise. The procedure was analgous to the yes-no method of human psychophysics in that one response was defined as correct and reinforced if the tone were present in the noise, and another response was correct and reinforced if the tone were absent. The percentage of correct responses was determined by the energy in the tone for the range of durations studied (75-600 msec.), e.g., if the tone's duration were halved, its power was doubled to keep the percentage of correct responses about the same. The ratio of energy in the tone to power/cycle of noise needed to maintain 75% correct responses was about 36 dB. for one *S* and 41 dB. for the other. Although the two responses were similar, and their consequences equal, biases in responding were sometimes observed.

Jeffress, Lloyd A. & McFadden, Dennis. Differences of interaural phase and level in detection and lateralization. *Journal of the Acoustical Society of America*, 1971, 49(4, Pt. 2), 1169-1179.

By employing the same narrow band of noise (50 Hz wide, centered at 500 Hz.) as both masker and signal, and by introducing a phase-shifting network between the masking and signal channels, it is possible to control the phase angle, ALPHA, between the two. For a given signal-to-noise ratio, controlling the phase angle controls the relative magnitudes of the interaural phase (time) difference and the interaural difference in level between the stimuli at the two ears. When ALPHA lies between 0 and 90. and the signal is reversed at one ear relative to the other, the interaural time and level differences favor the same ear. However, when ALPHA is between 90 and 180., the ear that leads in phase or time will receive the weaker stimulus, thus putting time and intensity into opposition as cues to the lateralization of the stimulus. Data on both detection and lateralization were obtained in two experiments with seven

Ss, using the single-interval forced-choice procedure. Large masking-level differences were found at all values of ALPHA, and good detection was exhibited even at those values of ALPHA where time and intensity were in opposition, and where performance in lateralization was very poor. Substantial individual differences in the relative importance of time and intensity as cues were found among the Ss.

Jerger, J. Principles and limitations of the Rainville methodology. Audiology, 1971, 10(3), 129-137.

Considers M. Rainville's methodology which is based on the principle that bone-conducted noise masks air-conducted tones in inverse proportion to degree of sensorineural hearing loss. Principle advantages of the methodology are (a) ease of calibration, and (b) the virtual elimination of the problem of cross hearing. The principle limitation is that sensorineural level is always measured in the occluded state. As a result, comparison of test results with bone-conduction levels obtained in the unoccluded state on patients with conductive loss can only be made by correcting for the average occlusion effect of the earphone used to deliver air-conducted tones to the test ear. This problem can be overcome by the use of earphones that do not produce an occlusion effect. Of the several available test procedures based on this methodology the simplest and easiest to administer is the SAL test. A recent modification in scoring the SAL test is described which permits direct calculation of the conductive component rather than expressing sensorineural level relative to an absolute norm.

Jesteadt, Walter H. & Bilger, Robert C. Frequency discrimination near masked threshold. Perception & Psychophysics, 1969, 6(6-B), 405-408.

Frequency DLs (DELTAf) were obtained at 1000 Hz. in quiet and under masking conditions similar to those used in pitch-shift experiments, narrow-band noise at levels of 60, 80, and 100 dB. SPL and tones at 15 dB. SPL or less. The DELTAfs were obtained by means of tracking task in which five undergraduates and three laboratory staff members controlled the input voltage to a frequency modulator. Characteristic improvement was seen when DELTAf was plotted as a function of sensation level. However noise level itself was a significant factor, with more intense noise resulting in larger DELTAfs for tones of equal sensation level re masked threshold. This departure from previous findings is attributed to the signal and noise levels used, although the possibility exists that it is due to the use of modulated tones.

Keith, R. W. & Talis, H. P. The effects of white noise on PB scores of normal and hearing-impaired listeners. *Audiology*, 1972, 11(3-4), 177-186.

Ten *S*s with normal hearing, 10 with high-frequency hearing loss, and 10 with relatively flat hearing loss were selected to serve as experimental listeners. All listeners yielded phonetically-balanced (PB) scores in quiet of 92% or better, i.e., a hearing impairment was not reflected in the PB score obtained in quiet. Central Institute for the Deaf Auditory Test W-22: Phonetically-Balanced Words List 1 and 2 were presented at 40-dB sensation level, the sensation level necessary for PB maximum. Words were presented in quiet and in the presence of white noise. Three signal-to-noise (S/N) ratios were used: +8, 0, and -8 dB. As the noise interference level increased, PB scores deteriorated. The PB score of normal hearing *S*s deteriorated approximately 52% from the quiet to the -8-dB S/N ratio, *S*s with high-frequency hearing loss deteriorated approximately 57%, and *S*s with flat hearing loss approximately 67%. The PB scores of groups at the -8-dB scores of groups at the -8-dB S/N condition were significantly different at the .01 level of confidence.

Kumar, P. & Mathur, C.N. Sex and Noise Distractibility. *Indian Journal of Applied Psychology*, 1969, 6, 13-4.

Forty male and 40 female graduate students were given (a) a mechanical cancellation task, and (b) a mental task involving simple arithmetic. Noise was produced by two high-pitched electric bells. It was found that with female *S*s, noise had a facilitating effect on the mechanical task and did not cause a deterioration in performance on the mental task.

With male Ss, deterioration was found in both tasks.

Larkin, Willard. Response mechanisms in detection experiments. Journal of Experimental Psychology, 1971, 91(1), 140-153.

Four Ss were required to rate the subjective loudness of tones presented in noise and to make decisions as to the presence or absence of signals. Loudness ratings and detection decisions were studied in separate experiments and then in experiments which required both responses to be made on each trial. The loudness judgments were stable across sessions and signal probability conditions, and the two responses could be made on the same trials with no discerning interference. The relation between the two responses was compared with predictions from psychological models. While the data support the view that detection responses are composed of sensory and decision stages, they are inconsistent with several traditional models. A variable criterion model is proposed which gives a good account of the detection data.

Larkin, Willard & Greenberg, Gordon Z. Selective attention in uncertain frequency detection. Perception & Psychophysics, 1970, 8(3), 179-184.

Uncertain frequency detection of brief sinusoids in noise were studied in a special Yes-No paradigm that included single-frequency trials randomly interleaved with trials on which either of two frequencies could be presented. Contrary to implications from previous studies, and to sensory filter models of attention, Os' deliberate attempts to impose narrow- or wide-band listening had only a small effect on the relative detectability of signals at 500 and 1100 Hz. If frequency selectivity is to be understood as sensitivity adjustment (rather than as a recognition process), the relevant parameters may be entirely stimulus determined.

Leshowitz, Barry. Measurement of the two-click threshold. Journal of the Acoustical Society of America, 1971, 49(2, Pt. 2), 462-466.

Os discriminated between a pair of 10-μsec pulse and a single 20-μ sec pulse having the same total energy. The independent variable was the time, DELTAT, between the two 10-MUsec pulses. The stimuli were also presented as elements in a periodic pulse train. The DELTAT required for resolution of two clicks (two-click threshold) was 10 MUsec. Whereas the addition of a steady background noise produced a remarkably small change in the magnitude of the two-click threshold, performance deteriorated markedly when the pulses were low-pass filtered. It appears that discrimination of slight changes in the energy spectrum of the two transient signals, especially in the high-frequency region (8000 Hz. and above), underlies the ear's sensitivity to a temporal discontinuity.

Leshowitz, Barry & Wightman, Frederic L. On-frequency masking with continuous sinusoids. *Journal of the Acoustical Society of America*, 1971, 49(4, Pt. 2), 1180-1190.

The detectability of brief, 1000 -Hz sinusoids added in phase or in quadrature to a continuous tonal masker (pedestal) of the same frequency as the signal in the presence of a continuous wide-band noise was examined. *S*s were three undergraduates, serving in each of two experiments. The effects of signal duration, shape of the signal's energy-density spectrum, SPL of the pedestal, and noise spectrum level were investigated. For conditions in which the background noise level was low, two unusual phenomena were noted: (a) a complete absence of the customary trading relation between signal power and duration, and (b) an extremely shallow masking function relating signal SPL and pedestal level. These departures from the law of temporal integration and Weber's law are consistent with a simple filter model of the ear in which it is assumed that the location of the auditory filter is altered to changes in the parameters of the signal and masker. A basic assumption of the model is that the location of the filter is changed in order to maximize the ratio of signal energy to masker energy at the output of the filter. For detection of a tonal signal in the presence of another sinusoid, it appears that *S* can listen at frequencies far removed from that of the signal, where signal energy is as much as 40 dB. down from the peak.

Letourneau, J.E. The influence of a white noise on the reversibility of the nucker cube. *American Journal of Optometry & Archives of American Academy of Optometry*, 1971, 48, 568-72.

Reversibility rates were studied in twenty-five 16-28 year old *S*s looking at a Necker cube while hearing a sound of 1,024 Hz at intensities of 50, 60, 70, 80 and 90 dB. Rate of reversibility was lowered by sounds of 80 and 90 dB. Time of adaptation and retinal rivalry had no effect, while the active and passive attitude of the *S*s influenced the rate of reversals.

Ling, Daniel, Heaney, Carole, & Doehing, Donald G. The use of alternated stimuli to reduce response decrement in the auditory testing of newborn infants. *Journal of Speech & Hearing Research*, 1971, 14(3), 531-534.

Two narrow-band noises, one centered on 2,000 Hz. (Stimulus A), the other on 1,250 Hz. (Stimulus B), were used to study behavioral response decrement among 400 newborn infants. A set of three presentations was administered to each *S* at 90-dB SPL. Interstimulus intervals were not less than 60 sec. For 1/2 the *S*s, stimuli within sets were repeated (either AAA or BBB); for the remainder, alternated (either ABA or BAB). Response decrement occurred under the first condition, but not under the second.

Lovell, John Dewey. Contralateral and ipsilateral pitch shift in wideband white or pink noise. (Doctoral dissertation, University of California) Ann Arbor, Mich.: University Microfilms, 1971, No. 72-2854.

Pitch matches were made between a fixed standard tone at 100, 400, or 1600 Hz and a variable frequency tone occurring at different time periods in the right ear. A 40 dB SL wideband white or pink noise occurred at the same time as the standard tone in either the right or left ear. When white noise was in the right ear, the results were similar to those of previous investigations. Shifts at 100, 400, and 1600 Hz were respectively about 0, 0.8, and 1.2 percent of the standard frequency, and were in an upward direction. When pink noise was in the right ear, pitch shifts were more negative by about 0.5 percent of the standard frequency.

if pink or white noise were presented in the left ear, pitch shift was of a comparable magnitude to the case of the right ear, but the shift produced by pink noise was not consistently more negative than that produced by white noise.

McCommons, R. Bruce & Hodge, David C. Comparison of continuous and pulsed tones for determining Bekesy threshold measurements. Journal of the Acoustical Society of America, 1969, 45(6), 1499-1504.

Two studies were performed to determine the parameters affecting the sensitivity and variability of Bekesy thresholds. Exp. I (N=10 19-35 yr. old males) was concerned with the effects of varying period, duty cycle, and frequency on threshold measurements obtained using pulsed tones and was done to derive an "optimal" pulsed tone. Exp. II (N= three 20-24 yr. old undergraduates, highly trained) compared thresholds taken using the optimized pulsed tone to those obtained with continuous tones. The effects of varying attenuation rate with both types of presentation were also investigated. Pulsed tones were found to yield superior threshold measurements both in terms of greater sensitivity and less intratest variability. Also, continuous tone thresholds were found to be susceptible to changes in attenuation rate whereas pulsed tone thresholds were not.

McFadden, Dennis & Pulliam, Kenneth A. Lateralization and detection of noise-masked tones of different durations. Journal of the Acoustical Society of America, 1971, 49(4, Pt. 2), 1191-1194.

On different blocks of trials, three Ss either detected or lateralized a monaurally presented signal in a binaurally presented noise masker. Eight values of signal duration, ranging from 50-800 msec., were used for both detection and lateralization. The psychometric functions for lateralization and those for detection differed in form, but, despite this difference, both were displaced toward greater signal levels at about the same rate as signal duration decreased. That is, the difference between lateralization and detection was approximately the same for all signal durations. Signal: 400 cps. Masker: wide band noise, 45 dB. SPL/cycle. Method: single interval forced choice.

McFarland, William H. & Weber, Bruce A. An investigation of ocular response to various forms of sound field auditory stimulation. Journal of Auditory Research, 1969, 9(3), 236-239.

Three different methods of sound field auditory stimulation were presented to 12 normal-hearing young adults (a stationary white noise, a white noise that alternated from side to side, and a rotating white noise). Only the rotating sound stimulus condition created changes in eye movements significantly different from those observed in controls. The highly variable form of the response, the high rate of spontaneous responses and the amount of time necessary to judge the records make this technique appear clinically unfeasible.

Melamed, Lawrence E. & Thurlow, Willard R. Analysis of contrast effects in loudness judgments, Journal of Experimental Psychology, 1971, 90(2), 268-274.

Evaluated the relative contributions of a pooled adaptation level and nonsensory processes in the formation of contrast effects in loudness judgments using both a category scale and a maximally extensive, number-response language. Results with 160 female undergraduates indicate that obtaining a contrast effect is not dependent on certain restrictive features of the category-judgment language. However, the formal properties of the contrast effect were found to be characteristically different from those derived from a sensory interpretation of its origin. A memory-shift interpretation of S's judgments is presented.

Melamed, Lawrence E. The role of response processes in the formation of cross-modality assimilation effects. Perception & Psychophysics, 1970, 8(3), 185-188.

Found the enhanced judgments of intensity of soft tones judged along with a series of bright lights (assimilation effect) to be dependent on the fact that the lights were judged coincidently. Ss were 90 female undergraduates. This dependence was not observed in a parallel investigation of contrast effects in judgments of tones alone. Both the form of the assimilation effect and its specific dependence on judging both stimulus modalities argues against a sensory explanation. Instead, it is argued that this cross-modality assimilation effect represents a resolution of the specific difficulties involved in judging two qualitatively different modalities on one judgment scale.

Mendel, Maurice I. Infant responses to recorded sounds. *Journal of Speech and Hearing Research*, 1971, 11(4), 811-16.

Thirty, 4-11 month old infants were tested with five different recorded sounds that varied in bandwidth and temporal configuration: a continuous band of white noise, the same band of noise interrupted twice/sec, the crinkling of onionskin paper, a narrow band of noise centered at 3000 Hz, and a warbled 3000 Hz tone. With loudness and duration of the stimuli held constant, more responses occurred to sounds composed of a broad-band spectrum than to those of a limited bandwidth. Temporal configuration of the sound had no effect on the number of responses elicited.

Moss, Stanley M., Myers, Jerome L., & Filmore, Thomas. Short-term recognition memory of tones. *Perception & Psychophysics*, 1970, 7(6), 369-373.

Four right-handed undergraduate male *O*s participated in a recognition memory experiment for five weeks. *O* was required to judge whether two temporally sequenced tones of varied interstimulus interval (ISI) were the "same" or "different". Latencies and confidence ratings were obtained for each judgment. TSD analyses applied to individual *O*'s data indicated consistent and rapidly decreasing d's as a function of ISI. Receiver-operating characteristic functions generated from the latencies and ratings produced comparable results, indicating the feasibility of using latency measures along with the type of judgments made to obtain sensitivity measures. Response bias, as indicated by the differences in the latencies between "same" and "different" judgments, did not produce consistent trends.

Mulligan, B. E. & Elrod, M. Monaural detection and filtering. Journal of the Acoustical Society of America, 1970, 47(6, Pt. 2), 15[illegible]-1556.

Monaural detection of sinusoidal signals in noise were examined parametrically with an interest in extending earlier work on prediction by B.E. Mulligan and M. Elrod. The amplitude model is found to be compatible with empirical psychometric functions, human receiver operating characteristics, and the results of a narrow-band-noise experiment. Through an interpretation of the amplitude model in terms of filter bandwidth, an attempt is made to understand further the process of auditory filtering. Bandwidth is shown to vary as a function of both signal frequency and signal-to-noise (S/N) ratio. At very low S/N ratios, maximal tuning occurs in the region of 2200-2300 Hz. At higher S/N ratios, tuning improves as a function of frequency. To facilitate prediction, a table is provided.

Murphy, E. H. & Venables, P. H. The effects of caffeine citrate and white noise on ear symmetry in the detection of two clicks. Neuropsychologia, 1971, 9(1), 27-32.

Previous studies were shown that when one or two clicks are presented monaurally with white noise in the contralateral ear, there is considerable decrement in detection of two clicks presented to the right ear but little change in detection for the left ear in comparison to the performance without contralateral noise. Thirty-six right-handed male and female undergraduates performed a signal detection task. An inverted U function was obtained when performance was tested with placebo, 375 or 500 mg. of caffeine citrate, for right and left ear, with and without white noise. The relative superiority of the right ear performance without caffeine citrate or white noise was significantly correlated with right ear decrement with caffeine citrate or white noise. Results are discussed with reference to strength of the nervous system, arousal and differentiation of function of the right and left cerebral hemispheres.

Nober, Linda W. Auditory discrimination and classroom noise. Reading Teacher, 1973, 27(3), 288-291.

Auditory research clearly demonstrates that auditory perception is adversely affected by noise in the environment. Because of the presence of noise in the environment, the noise factor is purposely introduced into a variety of hearing tests by audiologists. Wepman's test on the other hand, has been standardized in a quiet environment and widely used as an index of a child's auditory discrimination does not serve as a valid index within the normal setting.

Osman, Eli. A correlation model of binaural masking level differences. Journal of the Acoustical Society of America, 1971, 50(6, Pt. 2), 1494-1511.

A quantitative functional model was presented, to be used for interpreting empirical results on binaural masking level differences (BMLDs), which are obtained in experiments on the detection of sinusoidal signals embedded in binaural noise. The receiver is presumed to behave as if it computes a statistical decision variable equivalent to a linear combination of three quantities, the energy levels at the channels deriving from the two ears and the interchannel cross correlation, where the coefficients are dependent on the interaural noise cross correlation and the interaural amplitude ratio for noise, but are completely independent of single parameters. Additive internal noise is assumed. Equations for BMLDs are derived with the restriction of equal noise levels at the two ears. Predictions derived from the model are compared with empirical results from several studies. These show BMLDs for antiphasic, homophasic, and monaural input configurations at different frequencies of tonal signal, and BMLDs for varying interaural correlations of signal and of noise, where the noise correlation is statistical or deterministic. Similarities and differences between the correlation model and another model, the equalization-cancellation model, are discussed.

Paul, Robert G. The effect of contralateral noise on intensive differential sensitivity as measured by two variants of the quantal stimulus pattern employing continuous versus discontinuous background tones. *Dissertation Abstracts International*, 1970, 30(9-B), 4398-4399.

Piazza, R. The masking of binaural beats of a pure sound with a differential sound. *Audiology*, 1972, 11(3-4), 169-176.

The masking of binaural beats between a pure tone, stimulating one ear, of f0 + d frequency (d = Hz.) and the differential sound originated in the other ear were examined by stimulation with the mixing of two pure tones of frequency f1, f2 (f2-f1 = f0). The masking sound was a third octave filtered white noise, of nominal frequency fn variable between 200-4,000 Hz., and variable sound pressure. For each fn and for each constant value of f0, f1, f2, the minimum SPL of the narrow band noises for masking the beat was measured as a function of the frequency fn; the SPL of the pure tones was maintained constant at 45 dB. the minimum SPL of the narrow band noises for masking the normal beats (a pure tone of 315 Hz. at the left ear, of 318 Hz. at the right ear) was determined. The latter measurement gave, as expected, a very deep minimum at 315 Hz.; from the other measurements some oscillations of experimental values occurred, with a mean value generally decreasing as the nominal frequency of the masking noise increased.

Pinheiru, Marilyn L. & Ptacek, Paul H. Reversals in the perception of noise and tone patterns. *Journal of the Acoustical Society of America*, 1971, 49(6, Pt. 2), 1778-1782.

Perception of auditory patterns based on an intensity difference in 20 experienced normal hearing *S*s was investigated under binaural and monaural listening conditions. Patterns were made up of either three white-noise bursts or three 1000-Hz tone bursts which were temporally spaced. Bursts within each pattern differed only in intensity and were either loud (L) or soft (S), i.e., either pattern included one of one intensity and two of the other. The six possible patterns were SLS, LSL, LLS, SSL, and SLL. The loud bursts remained at a constant intensity and the soft bursts were attenuated by either 9, 7, 5, or 3 dB. Patterns were presented at 50 dB sensation level. Tone-burst patterns were easier to perceive and resulted in a larger number of correct responses than noise-burst patterns. However, there was no significant difference between tone- and noise-burst patterns in the percentage of errors that were pattern reversals. Symmetrical patterns were reversed more frequently than asymmetrical patterns. Auditory pattern reversals are compared to figure-ground reversal and simultaneous contrast phenomena in vision and are discussed in relation to sensory inhibition.

Powers, Gerald William. A comparison of the auditory discrimination ability of average and retarded readers when the auditory stimulus is masked by noise. (Doctoral dissertation, University of Northern Colorado) Ann Arbor, Mich.: 1971, No. 71-27,791.

The Problem

The purpose of the investigation was to determine if a difference exists in the auditory discrimination ability of average and retarded readers when the auditory stimulus was masked by noise.

Procedure

The setting for this study was the Industrial Acoustics sound studio at the Special Education Laboratory School located on the campus of the University of Northern Colorado at Greeley. The subjects for this study consisted of thirty average readers and thirty retarded readers selected fifth and sixth grades of District Six, Greeley Public Schools, Greeley, Colorado. The test population was released from school, transported to the testing site by taxi, tested, and returned to school.

The purpose of this study required the measurement of each subject's speech reception threshold and auditory discrimination in quiet or when the auditory stimulus was not masked by noise. Therefore, this investigation considered three areas: (1) speech reception threshold, (2) auditory discrimination in quiet, and (3) auditory discrimination in a noise environment. An Allison 21 B Diagnostic Speech Audiometer, located in the sound field was used to measure these abilities. This study compared average and retarded readers on all three auditory tasks. The resulting scores were treated statistically using the "t" test of independent samples for means and the "F" test for variance.

Findings

1. There was no statistical difference in the mean speech reception thresholds for the average and retarded readers. There was no statistical difference in the subjects' variability for speech reception threshold.

2. There was no statistical difference in the mean auditory discrimination ability for average and retarded readers. There was no statistical difference in the subjects' variability for auditory discrimination ability.

3. There was a statistically significant difference in the mean auditory discrimination in noise performance of the average and retarded readers. In fact, the means were significantly different at the .0005 level, although this level was not set prior to the investigation. There was no statistical difference in the subjects' variability for auditory discrimination in noise ability.

Conclusions

There was no difference in the speech reception thresholds or auditory discrimination ability of the average and retarded readers when the auditory stimulus was not masked by noise. However, the auditory discriminating ability of the retarded readers was significantly lower than that of the average readers when the auditory stimulus was masked by noise.

Recommendations

The hearing diagnosis of children with reading problems should include an assessment of the child's auditory discrimination ability when the auditory stimulus is masked by noise.

auditory discrimination in noise discrepancies revealed in this research exist among the general reading disabled population and among children with learning disabilities in academic areas other than reading.

Raab, David H & Taub, Harvey B. Click-intensity discrimination with and without a background masking noise. *Journal of the Acoustical Society of America*, 1969, 46(4, Pt. 2), 965-968.

Three unusual effects of intensity discrimination employing click stimuli observed by two adult *S*s revealed: (a) clicks are difficult to differentiate with respect to intensity; (b) the Weber function differs from those usually obtained with stimuli of longer duration; and (c) click-intensity discrimination is improved by the addition of a continuous background noise. Since click stimuli have virtually no energy variations, the results cannot be explained by stimulus-oriented theories of detection and discrimination.

Rainbolt, Harry & Small, Arnold M. Mach bands in auditory masking: An attempted replication. *Journal of the Acoustical Society of America*, 1972, 51(2, Pt. 2), 567-574.

The research attempted to replicate the 1969 report of E. Carterette, M. Friedman and J. Lovell on the existence of auditory masking effects similar to Mach bands in visions. Thresholds for sinusoids in anrrow bands of noise were estimated for five listeners using an adaptive psychophysical procedure. Results show little, if any, similarity to Mach band effects, but are in line with what would be expected based on a tradational critical band concept.

Richards, Alan M. Perception of pitch in a white-noise mask. *Journal of the Acoustical Society of America*, 1969, 45(5), 1180-1185.

Three mel scales were obtained, derived from fractionation data, and representing three differential noise conditions using 12 normal hearing adults. The no-noise function differed in no essential manner from the generally accepted mel scale advanced by S. S. Stevens (see PA, Vol.

14:5362). However, upon the introduction of a wide-band masker, the shape of the mel function became more positively accelerated. In general when holding the intensity of the masker constant, this acceleration was inversely related to the sensation level of the experimental tones above masked threshold, and was not frequency dependent. Although this relationship is not dependent upon frequency per se, the magnitude of pitch shift increases with frequency.

Roberts, William Huddleston. The effect of pulsed and continuous test tones on the central masking effects from contralateral narrow-band noise stimulation. (Doctoral dissertation, Ohio University) Ann Arbor, Mich.: University Microfilms, 1970.

The purpose of this study is to identify some of the effects of central masking resulting from contralateral narrow-band noise. All subjects are tested with and without occlusion of the outer ear. Effects on two fixed frequencies, 500 and 4000 Hz are examined. Two types of test signals, pulsed and continuous, are used with the contralateral narrow-band masking.

A diagnostic test battery consisting of Bekesy audiometry, the SISI test, and the Monaural Loudness Balance test was selected for the experiment. Recent research has indicated that contralateral narrow-band masking will depress the thresholds of a test ear and that the shift is most pronounced when a continuous test tone is presented simultaneously with continuous masking or a pulsed tone is presented with pulsed masking. A Type II Bekesy pattern was also observed when the Bekesy pulsed tone tracing was compared with the continuous tone tracing. In addition, positive SISI scores have been reported with contralateral white-noise masking at 80 dB. SPL. There was no report found in the literature which used a test battery to study the effects of central masking.

Twelve adult female subjects who had a pulsed tone pre-test threshold of 10 dB or better were selected for study. Two experimental sessions utilizing the above mentioned test battery were held. In the first session thresholds were obtained in quiet and with 40 and 60 dB, SL, Contralateral narrow-band masking. The identical procedure was used for the second sessions except that the test ear was occluded by a plug of Swedish Wool in order to raise the subject's auditory threshold. Effects of the masking on the thresholds of the two test frequencies, 500 and 4000 Hz, were examined by Bekesy audiometry. SISI scores were obtained for the 4000 Hz tone, only using all conditions of masking. In addition a SISI score was obtained at 4000 Hz with the test tone elevated to 70 dB, SPL. For the MLD 500 Hz was used for the reference tone and 4000 Hz for the test tone.

Rochester, Sherry. Detection and duration discrimination of noise increments. *Journal of the Acoustical Society of America*, 1971, 49(6, Pt. 2), 1783-1789.

When weak signals are presented in a background of continuous noise, the process of detection and the discrimination of a change in duration appears to be very similar. Two experimental techniques were used (with one male and two female listeners in each group) to investigate duration discrimination. The procedure in which the difference in duration between signals, DELTAT, was varied given a fixed signal-to-noise ratio gave different results than the procedure in which signal amplitude was varied given a fixed DELTAT. Although there were marked individual differences, all *S*s roughly supported the general conclusion.

Sandusky, Arthur, & Ahumada, Al. Contrast in detection with gated noise. *Journal of the Acoustical Society of America*, 1971, 49(6, Pt. 2), 1790-94.

In two experiments with 10 undergraduates and young faculty members, the response bias in yes-no detection with gated noise and simultaneously gated signal plus noise was found to show both sequential and probability contrast. The sequential dependencies showed that the more recent a signal event, the more the response bias shifts away from yes. Similarly, the more probable the presentation of a signal, the more the response bias shifts away from yes. The response bias in detection with continuous noise usually shows the opposite effect response assimilation. The probability of a yes response increases with either greater probability or with signal recency. It is suggested that the response-bias learning which has been postulated to occur in detection experiments depends on the stability of the judgmental frame of reference provided by the continuous noise. When this basis is removed, as in the present study, the response pattern parallels that usually observed in signal recognition studies for which responses are assumed to depend on the memory of the previous presentations. It is concluded that the response pattern assimilation or contrast depends more on the stability of the frame of reference than on the type of psychological task.

Scharf, B. & Fishken D. Binaural summation of loudness: Reconsidered. *Journal of Experimental Psychology*, 1970, 86(3), 374-379.

Loudness functions for a 1000-Hz tone and a white noise, presented monaurally and binaurally were measured by the methods of magnitude estimation and magnitude production. Results suggest that the ratio of binaural to monaural loudness for tone and noise is between 1.6 and 1.85 over an intensity range from 40- to 110-dB SPL. Within this range, the ratio for white noise increases with SPL, but does not exceed two. The loudness functions for monaural and binaural tones are power functions with the same exponent, whereas those for noise are not power functions but are bowed, on log-log coordinates, relative to the tone functions, being being steeper below about 50- dB SPL and flatter above. The loudness of binaural noise increases more rapidly with SPL than the loudness of monaural noise.

Smith, Gudmund J., Sjoholm, Lena & Andersson, Alf L. Effects of extraneous stimulation on afterimage adaptation. *Psychological Research Bulletin*, 1970, 10(7), 10 p.

Projected afterimages (AI) were measured serially with respect to size, intensity, and color. It was predicted that an acoustic signal administered before completion of the adaptive AI process would cause: (a) disruption of ongoing trends, (b) regression to initial trends, (c) prolongation of the adaptive process, and (d) at least some defensive reactions. Predictions were substantiated in a group of 26 undergraduates and nonsevere cases from a psychiatric clinic compared with 26 controls.

Smith, Paul F. & Koch, Martha. Sonar doppler discrimination in high noise environments. *U.S. Naval Submarine Medical Center Report*, 1971, 661, 12 p.

The ability of antisubmarine warfare helicopter-borne sonarmen to perform doppler discrimination in the high background noise existing aboard rotary winged aircraft was studied. *S*s were 45 enlisted men. Performance on a frequency discrimination task was measured under conditions in which the background noise was varied in intensity up to levels approaching those found aboard helicopters. The level of the signal was also varied such that under some conditions the signal was only slightly audible above the noise while under some conditions the signals were clearly audible. It was found that the intensity of the noise was not, of itself, related to the acuity of frequency discrimination. Pitch discrimination was relatively unaffected by noise level but greatly dependent on sensation level. A significant interaction between noise level and sensation level was observed.

Schulman, Arthur I. & Greenberg, Gordon Z. Operating characteristics and a priori probability of the signal. *Perception & Psychophysics*, 1970, 8(5-A), 317-320.

Two experiments in auditory signal detection produced changes in the operating characteristic as the a priori probability of signal occurrence, p(SN), was varied. The signal was a sinusoid of 1000 Hz. presented for 250 msec. against a continuous background of noise to 6 listeners. In Exp. I, three values of p(SN) .25, .50, and .75 were paired with each of 3 signal intensities. In Exp II, the signal intensity was fixed and p(SN) was assigned values of .10, .25, .50, .75, and .90. On normal-normal coordinates, operating characteristics were fitted to the points obtained from the 4-point rating scale used by *S*s. Such characteristics may be specified by two parameters: ds, and index of detectability related to d', and m, its slope. While ds was found to be independent of p(SN), m was found to be independent of p(SN), m was found to be a joint function of p(SN) and signal intensity. Results are discussed against the background of the theory of signal detectability.

Snyder, Jack M. The influence of contralateral noise on auditory adaptation in normal listeners. *Dissertation Abstracts International*, 1972, 32(9-B), 5514.

This study was designed to examine the effects of technique and of contralateral noise masking on the amount of threshold tone decay found in normal ears.

Forty adults with normal hearing were asked to maintain sensitivity threshold for tonal stimuli over periods of sixty seconds. Temporal data were recorded at each of the intensity increments, in 5 dB steps, which were required to maintain threshold. Each subject received forty stimulus conditions: two test paradigms (the Carhart and the Owens techniques) presented at four frequencies (500, 1000, 2000 and 4000 Hz) in quiet and in four conditions of contralateral noise (40 dB narrow-band). Presentations order was counterbalanced to preclude biased results.

No significant differences were found between the results obtained with the two test techniques.

Moderate degrees of tone decay were shown in the quiet condition. Such findings had previously been attributed to the presence of cochlear lesions. Mean and maximum levels of tone decay increased as a function of stimulus frequency.

Similar results were found for the experimental noise condition. Statistically significant tone decay differences were related to the frequency of the test tone, the sensation level of the masker (40 dB vs 60 dB SL), and the masker band width (broad-band noise vs narrow-band noise centered around the test tone). Under masked conditions there were relatively high percentages of subjects who demonstrated degrees of decay which would be interpreted as being pathognomonic of retrocochlear auditory lesions.

Data from masked conditions were further analyzed as to the influence of the central masking phenomenon.

Thurlow, Willard R. & Mergener, James R. Effect of stimulus duration on localization of direction of noise stimuli. Journal of Speech & Hearing Research, 1970, 13(4), 826-838.

Localization of the direction of bursts of thermal noise by untrained undergraduates was measured for both high- low- frequency bands, as a function of duration of bursts. Durations of .3, 1, 2, and 5 sec. were used. Ss were free to move their heads to aid in localization. With increase in stimulation duration, perception of elevation was slightly improved for low-frequency noise, probably due to increased information from head movement. A minimum performance (which still was not very good for these low-frequency stimuli). Perception of the elevation of the high-frequency noise sources was relatively good even at the briefest durations. Perception of front-back source position was much improved for both low- and high- frequency noise when stimulus duration was increased. Results are discussed in terms of the increased possibility for head movement with increase in stimulus duration.

Tonning, F. M. Directional audiometry: III. The influence of azimuth on the perception of speech in patients with monaural hearing loss. Acta Oto-Laryngologica, 1971, 72(6), 404-412.

The directional threshold of intelligibility (DTI) was measured both with and without background noise, in 37 patients with one-sided hearing defects ranging from a 30-dB loss to total deafness. Free field speech audiometry was done with an apparatus permitting independent radial positioning of a speech and a noise loudspeaker on S's head. It was found that DTI without noise was determined not only by the amount of the hearing loss in the defective ear, but also by slight variations in the hearing ability of the good ear. A relationship was also found between the DTI without noise the normal ear's Pure Tone Average (PTA) in the range 500, 1000, and 2000 Hz. When speech was reproduced against background noise, the bad ear contributed to the perception of speech if S had one sided PTA of 53- dB hearing level or less.

Tonning, F. M. Directional audiometry: IV. The influence of azmith on the perception of speech in aided and unaided patients with monaural hearing loss. Acta Oto-Laryngologica, 1972, 73(1), 44-52.

The directional threshold of intelligibility (DTI) was measured in 20 right-handed 12-68 yr. old patients with monaural hearing loss varying from a pure tone average of 20-dB hearing level to residual hearing. Without background noise, DTI with hearing aid was better than the DTI without hearing aid in two of the four positions of the signal loudspeaker. The difference was statistically significant, at $p < .05$. With background noise, DTI with hearing aid was significantly better than without hearing aid in 6 of the 16 combinations of signal and noise loudspeakers. For all 20 experimental listening conditions, DTI was better with hearing aid than without in 11 Ss. For the 16 experimental listening conditions with background noise, a significantly better DTI was found in nine Ss. Two Ss showed a poorer DTI with hearing aid than without. Results indicate the importance of evaluating the effect of hearing aid treatment of monaurally hard-of hearing patients after a sufficiently long trial period.

Viemeister, N. F. Intensity discrimination: Performance in three paradigms. Perception & Psychophysics, 1970, 8(6), 417-419.

Performance was compared in the following auditory intensity-discrimination paradigms: (a) 2IFC, (b) single-interval rating with an intensity cue preceding each observation internal, and (c) single-interval rating with no cue. Receiver-operating characteristic curves obtained in the single-interval conditions could be approximated by assuming that the underlying distributions were both normal and had equal variance. No larger difference was observed between performance in the cue and the no-cue conditions. The normalized separation of the means for 2IFC was approximately twice the corresponding estimate for the single-interval conditions, i.e., d2 = 1.91d1. This is consistent with the hypothesis that the O in intensity-discrimination tasks bases decisions on the difference between the observed input and that of a noisy stored reference. The familiar result that d2 = (2)1/2 d1 can be predicted for simple detection.

Viemeister, Neal F. Intensity discrimination of pulsed sinusoids: The effects of filtered noise. *Journal of the Acoustical Society of America*, 1972, 51(4, Pt. 2), 1265-1269.

It has been shown repeatedly that Weber's law does not hold for intensity discrimination of pulsed tones. The masking function for such waveforms (10 logDELTAI vs. logI, for constant performance) typically is linear with a slope of 0.9 over a range in I of at least 60 dB. Results of an experiment with two listeners indicate that the slope of the masking function increases from 0.9-1.0 as regions above the signal frequency are masked by filtered noise. A sufficient condition for a slope of 1.0 is a high-pass noise which masks regions at and above the second harmonic of the signal. This suggests that the "near miss" to Weber's law reflects the *O*'s use of information at aural harmonics. A model based upon this notion gives a good quantitative account of the data. The amount of distortion assumed in the model is in reasonable agreement with other data.

Warner, Harold D. Effects of intermittent noise on visual search tasks of varying complexity. *Dissertation Abstracts International*, 1971, 31(11-B), 6963.

The diverse nature of the results of studies investigating the relationship of intermittent noise and human behavior suggest that noise produced performance effects are dependent on the combination of the unique characteristics of the sound stimulus and the nature of the performance task. The purpose of this investigation was to test the interaction of intermittent noise and task complexity with parameters selected on the basis of the degree to which they simulate actual work situations. The noise was varied in terms of the total noise on-time in successive intervals, i.e., the on-off ratio of the sound stimulus. The ratios utilized were 30, 70, and 100 percent noise on-time in successive five second periods. Subjects were also tested with noise absent which served as a control comparison. The performance task was a visual search task which required the subjects to scan a display and report whether the display contained a critical "target". The target was an odd, or dissimilar, letter randomly positioned among a background of single letter characters. This configuration of letters was prepared on 35 mm. slides and was projected on a screen. A target appeared on an average of once every five slide presentations. The number of background characters defined the level of task complexity. The number of background letters used among which a target could appear was 8, 16, and 32 letters. Twenty-two subjects were tested under all noise and task combinations, a total of 12 test conditions per subject. Analyses of the data, measured on the parameters of target search time, and detection error, confirmed the hypothesis that noise effects are dependent on the nature of the performance task. Furthermore, it was shown that noise effects change over time as a function of adaptation and operator fatigue. Detection errors and latency over time were observed to shadow each other in a series of "saw-tooth" configurations. This was suggested to result from changes in arousal as the time at task progressed. Noise effects on reaction time for the various task complexity levels were hypothesized to be related to changes in operator arousal due to the rate of signal presentation and differences in the total stimulus input of the noise stimulus.

Webster, J. C. & Lepor, M. Noise, you can get used to it. Journal of the Acoustical Society of America, 45(3), 751-7.

On the basis of several laboratory studies, a three band preferred frequency speech interference level (PSIL) of 64 dB (based on the octaves centered at 500, 1000, and 2000 Hz.), or an A-weighted level (LA) of 71 dB., were proposed as the criteria levels for acceptable voice communications. Two validation surveys were undertaken where ambient noise levels were measured and subjective questionnaires were completed in various ships' spaces. Ss rated a space along a five point scale of noisiness (very quiet, quiet, moderately noisy, very noisy, and intolerably noisy); responses tended to center on moderately noisy regardless of objective noise level.

Webster, John C., Woodhead, Muriel M., & Carpenter, Alan. Perceptual constancy in complex sound identification. British Journal of Psychology, 1970, 61(4), 481-489.

This research investigated whether there are perceptual constancies between classes of complex sounds, even though the acoustic information is very different. Seventeen male listeners identified sounds consisting of vowels, musical instrument tones, and meaningless buzz sounds, presented at three different fundamental frequencies (octave shifts), and at three signal-to-noise differentials. The sounds were numbered but not named. The vowels had voice-like quality in mid-octave (110 Hz.); the musical tones sounded music-like at the highest octave (220 Hz.); at the lowest octave (55 Hz.) both music and vowels were physically meaningless; the meaningless buzz sounds had no greater relevance in one octave than any other. These buzz sounds could be distinguished from each other by differing harmonic patterns. It was found that, in the absence of masking noise, the vowels were better identified in midoctave than were the musical and meaningless sounds. The musical sounds were not better identified than the others in high octave. The meaningless sounds were unexpectedly easier to identify in the low octave. They generally withstood thermal noise masking well, but not buzz masking, compared with the musical and vowel sounds. It was more difficult to identify musical and vowel sounds during thermal noise masking than during buzz masking. It is concluded that the fixed ratio hypothesis is not applicable to vowel (formant) sounds within the octaves tested, but may be used to explain the constancy of identification for sounds which depend on harmonic patterning.

Young, I. M. Effects of ipsilateral masking on Bekesy amplitude. *Journal of Auditory Research*, 1968, 8(4), 357-365.

Bekesy amplitude width for both pulsed and continuous signals was studied in quiet and in the presence of ipsilateral masking stimuli for three normal listeners and for 48 patients with pure sensorineural hearing loss; tracing width was found to be similar with and without masking. Amplitudes were not affected by masking intensity level, different masking stimuli, or ascending or descending method for both sweep- and discrete-frequency tracings in normal and pathological ears. White noise and narrow band noise were used as a masker when pure tone was the test stimulus, and pure tones were used as masking stimulus when testing with white noise.

Young, I. M. Effects of pure-tone masking on low-pass- and high-pass-filtered noise. *Journal of the Acoustical Society of America*, 1969, 46(5), 1206-1209.

Threshold measurements for low-pass and high-pass-filtered noise were obtained in the presence of pure tones in three trained listeners with normal hearing. High-pass-filtered noise with cutoff frequencies at 2400 Hz. and above yielded masking peaks near the cutoff frequencies. When noise was filtered with cutoff frequencies at 1200 Hz. and below, pure tones of 800 and 1000 Hz. had the greatest masking effect. For low-pass-filtered noise, as the bandwidth increased, masking peaks moved from low frequency to high. The masking effect was indistinguishable from that of white noise when filtered noise was cutoff at frequencies of 2400 Hz. and above. Results suggest that there is a definite mechanical resonant frequency effect on noise when the width of filtered noise exceeds a critical value. Masking effects are discussed in relation to mechanical resonant frequency and the interaction of difference and summation tones.

COGNITIVE AND LEARNING

The findings relative to the learning and cognitive effects of noise are not easily interpreted. There are seeming inconsistencies in the results of many experiments. These discrepancies may be due to the specific noise levels and tasks involved, especially if an arousal effect takes place. Further, research is needed to clarify the exact relationships between the arousing and distracting effects of noise.

Some researchers in this area have noted noise-induced facilitation of learning and cognitive performance (e.g. Archer & Margolin, 1970; Fechter, 1972; Houston, 1969, 1971; Rosenberg & Jarvella, 1970; Samtur, 1969), while others observe a decrement in performance (e.g., Bates & Howath, 1971; Brown & Jackson, 1971; Finkelman, 1970; Hartley & Adams, 1973; Rai, 1973; Hartley a,b; Nober, 1973; Renshaw, 1973). Some of the discrepancy appears to depend on the intensity and length of exposure of the noise. There seems to be no simple answer to the question of noise facilitation/impairment on cognitive tasks. In addition to the problems discussed above, some researchers have found sex, age, and socioeconomic differences (Anderson, 1973; Kumer, 1969; Mansfield,1971; Mathur, 1972). Others have shown differential effects depending on the kind of noise (Wolf & Weiner, 1972). Still others have found no affects at all (e.g. Mowsesiah & Heyer, 1973; Meyers, 1971). To further complicate the problem, Harcum & Monti (1973) have demonstrated that Ss will "cooperate" with the E on noise disturbance ratings unless this factor is controlled.

Allen, Dorothy, C. Noise tolerance categories and aspects of teaching. *Dissertation Abstracts International*, 1970, 31(5-A), 1986.

This study was designed to answer three questions: (1) Is there a relationship between a teacher's tolerance of noise and his teaching pattern as described by Flanders' Interaction Analysis? (2) Is there a realtionship between a teacher's tolerance of noise and age? (3) Is there a relationship between a teacher's tolerance of noise and his sex?

Of a population of 311 fifth and sixth grade teachers, a random sample of 30 participated in the study. During phase one, individual appointments were made to collect data on noise tolerance, age, and sex. Kinesthetic measurements as described by Aseneth Petrie were recorded for the purpose of validating the noise tolerance instrument.

The split-half method was utilized to determine the reliability of the noise tolerance instrument.

To establish the teacher's noise tolerance score video and audio tapes were utilized. Each participant viewed two 10-minute video tapes; and unknown to the participant, the sound track was exactly the same for each video tape. The first 10-minute segment was a sixth grade mathematics class, which was described as a purposeful activity; the second was the same class in the same room for a lunch period, which was described as a non-purposeful activity. The recorded sound level started at approximately 35 decibels and ended at approximately 100 decibels. The controls on the video and audio equipment were set at fixed points for testing each person. To mark the categories, "annoying" and "unacceptable" for the purposeful activity, the number of seconds that elapsed in the 10-minute period were recorded on two electric clocks. The same procedure was utilized for the 10-minute non-purposeful activity.

Phase two involved the coding of each teacher's classroom behavior. The instrument utilized was Flanders' Interaction Analysis. Three 20-minute visits were coded. From these data the teacher's Indirect/Direct ratio was computed.

The rank difference method was employed to test each of the hypotheses dealing with noise tolerance and Indirect/Direct ratio. The product-moment coefficeint of correlation was selected for testing the relationships between noise tolerance and age. The point biserial r was utilized for testing the relationships between noise tolerance and sex. Each hypothesis was tested for statistical significance at the .05 level.

The following conclusions were drawn on the basis of statistical likelihood from data collected in this study:

Of the five hypotheses relating to noise tolerance and Flanders' Indirect/Direct ratio, one correlation coefficient was significant. This statistical significance implies that a relationship existed between "annoying" noise during a purposeful activity and the Indirect/Direct ratios. These findings suggest that the more indirect teacher has a greater tolerance for noise described as "annoying" during a mathematics class.

Of the five hypotheses relating noise tolerance and age, there were two significant correlation coefficients. These significient coefficients were both in the area of purposeful noise. These findings suggest that the older the teacher the less tolerant he was of "annoying" noise and "unacceptable" noise during a purposeful activity. All of the correlation coefficients between noise tolerance and age were in the same direction (minus).

There were no significant correlation coefficients found in testing any of the hypotheses relating noise tolerance and sex. All of the coefficients were very low, indicating that even a chance relationship was negligible.

In comparing the correlation coefficients between noise tolerance during a purposeful activity and noise tolerance during a non-purposeful activity, all significant or even relatively high coefficients were in the area of purposeful activity. It would appear that the meaning the teacher brings to the noise in the educational setting is a factor in tolerance.

Alumbaugh, Richard V. & Takemura, Kenichi. Variable noise and informal transmission. Psychonomic Science, 1973, 27(6), 351-352.

This research describes an experiment with 75 undergraduates in which noise levels were varied systematically to determine the effects on information processing. Slides consisting of circular dots (relevant information) and triangles (irrelevant information) were presented tachistoscopically. Ss task was to correctly identify the number of dots. Dots varied from 3-12 quantitatively, while triangles varied from 0-3. Results suggest that noise may have a limen similar to channel capacity for relevent stimuli, and response set needs to be examined more closely as a biasing effect on information transmission.

Anderson, Patricia A. Social class, noise and performance. Dissertation Abstracts International, 1973, 33(6-B), 2784.

This study concerned the development and social class differences during three types of noise. Three classes each of second and sixth graders from a school in a suburban area of Washington state were tested on three kinds of performance items (Porteus Mazes, word completion, and counting) while listening through earphones to two four minute periods each of silence, white noise, and home noise. All children were white and without identified hearing problems. Sixty-one second graders and fifty-eight sixth graders were identified by socioeconomic status and served as subjects for the experiment. Results of the testing indicated significant differences on the noise by social class interaction variables for second graders. Middle class second graders do more poorly in the white noise and home noise condition than in the silence condition. Lower class children do equally well in each of the three conditions. Analysis of the sixth grade results indicated no significant differences although graphically the middle class sixth graders did equally well in the silence and white noise condition and better under the home noise condition. Lower class children did equally well in each of the three conditions. A comparison between middle class second and sixth graders was significant indicating that second graders do worse during the home noise condition than in the silence condition and sixth graders do better during the home noise condition than during the silence condition. A comparison with lower class second and sixth graders was not significant, suggesting no developmental differences.

Archer, Barbara U. & Margolin, Robert R. Arousal effects in intentional recall and forgetting. Journal of Experimental Psychology,1970, 86(1), 8-12.

Effects of white noise-induced arousal upon intentional remembering and forgetting was studied using 2-digit numbers vs stimuli, followed 3 sec. later by the instruction "remember it" or "don't remember". 16 stimuli (8 in conjunction with white noise and 8 without) were presented to 24 male and 24 female indergraduates. For 1/2 of the Ss, the noise, when it occurred, was presented just prior to the stimulus, while for the remaining Ss, noise occurred after the stimulus but prior to instructions. Significantly more remember items were recalled than don't remember items. White noise had no effect on intentional forgetting, but did produce significant facilitation of recall of remember items, and that facilitation was significantly greater for men than for women. A significant difference did not result for the temporal point of noise introduction.

Bates, F.C. & Horvath T. Discrimination learning with rhythmic and non-rhythmic background music. Perceptual & Motor Skills,1971, 33(3, Pt.2), 1123-1126.

The performance of 30 male Long-Evans hooded rats on a discimination problem was studiaed in a 4-choice apparatus while exposed to 1 of 6 auditory stimulus conditions: (a) a selection of Mozart, (b) an amelodic version of this piece, (c) a selection of Schoenberg, (d) an amelodic version of this piece, (e) white noise, and (f) quiet. None of the groups acquired the discrimination more quickly than quiet controls. Ss exposed to the Schoenberg music, the amelodic version of it, and to white noise performed more poorly than the controls. It is concluded that the presence of nonrhythmic auditory stimulation is detrimental to performance on a discrimination task.

Brown, C. & Jackson, D.E. The effects of high-intensity noise in early development upon behavior in the adult rat. Proceedings of the Annual Convention of the American Psychological Association,1971,6,207-8.

Following 30 days (age 26-56 days) of either high-intensity noise exposure or control conditions, 38 rats were subsequently either trained in a U maze or tested in an open field. Analysis of variance revealed significant Noise, and Noise X Sex interaction effects on U maze performance. No differences in the open field test were observed. These results suggest a differential sex effect of noise on subsequent learning where emotional factors have been controlled.

Cohen, Sheldon; Glass, David C., & Singer, Jerome E. Apartment noise, auditory discrimination, and reading ability in children. *Journal of Experimental Social Psychology*, 1973, 9(5), 407-422.

The relationship between auditory and verbal skills of 73 children in grades 2-5 and noise level of their homes was studied with expressway traffic as the principal source of noise. Initial decibel measurements in a high-rise housing development permitted use of floor level as an index of noise intensity in the apartments. *S*s living on the lower floors of 32-story buildings showed greater impairment on the Auditory Discrimination Test and Metropolitan Achievement Tests (MAT) than *S*s living in higher-floor apartments. Auditory discrimination appeared to mediate an association between noise and MAT reading deficits, and length of residence in the building affected the magnitude of the correlation between noise and auditory discrimination. Additional analyses ruled out explanation of the auditory discrimination effects in terms of social class did, however, somewhat physiological damage. Partialling out social class did, however, somewhat reduce the magnitude of the relationship between noise and reading deficits. Results are interpreted as documenting the existence of long-term behavioral aftereffects in spite of noise adaptation.

Fechter, John Vadnais, Jr. The effects of noise on human learning. (Doctoral dissertation, University of South Dakota) Ann Arbor, Mich.: University Microfilms, No. 72-32728.

A series of three experiments was conducted to determine the effects of noise on verbal and motor learning. In the first experiment, a low-level, irregular sound was presented during paired-associate learning and recall sessions. Motor learning on the pursuit rotor was accomplished with or without loud noise and with or without a subsidiary task in the second experiment. The last experiment concerned the effects of loud, intermittent noise on a complex compensatory tracking task and a subsidiary task.

Experiment I presented paired-associates comprised of consonant-vowel-consonant (CVC) nonsense syllables of 0% association value, paired with the numbers 0 through 9. A novel sound presented at 75 dB(A) which was presented alone or paired with shock did not produce any differences in the rate of learning, the time to respond to each associate, the number of trials to a criterion of three correct trials in a row, or the number of associates recalled on a re-test 24 hours later. A significant increase in the time required for responses to stimulus associates was observed for those conditions which presented sound and shock, but no difference in learning rates was observed.

Subjects in Experiment II were presented with the rotary tracking task, the turntable revolving at a rate of 30 revolutions per minute. When the task involved only pursuit tracking, white noise at 100 dB produced improved performance on every trial, in comparison to the quiet group. Those subjects who learned the task while decoding electrocutaneous signals produced a general improvement in tracking performance (time on target) over time, though the difference between groups was not statistically significant. Subsidiary task performance was much improved over time for the noise group, though not for the quiet group.

The compensatory tracking task of Experiment III involved an aircraft-type joystick control which the subject moved to control the position of a dot on a cathode ray oscilloscope. The position of the dot was changed continuously throughout the hour-long session by a non-repeating command course. Four times per minute, a binary light display above the oscilloscope was decoded by the subject. Subjects were presented either quiet or 100 dB white noise at an intermittency ratio of 70% sound - 30% silence. Statistical analyses indicated that learning did occur over time, but that there were no significant differences between groups, either in tracking efficiency or subsidiary task performance. These comparisons were based on the first 10 minutes of the task. A multiple discriminant analysis of total performance over the whole hour also failed to detect significant differences between groups. However, the same trend toward improved performance by the group exposed to noise (as found in Experiment II) was observed.

Finkelman, Jay M. & Glass, David C. Reappraisal of the relationship between noise and human performance by means of a subsidiary task measure. Journal of Applied Psychology, 1970, 54(3), 211-213.

This research investigated the notion that where demands imposed by the task and concurrent environmental stress are within the operator's total information-handling capacity, the task can be performed substantially without errors. For performance degradation to occur, the operator's channel capacity must be exceeded. It was assumed that unpredictable noise in combination with multiple task performance would result in such an overload, whereas the introduction of predictable noise would not have such an effect. Ss were 23 undergraduates. A subsidiary task method consisting of the delayed recall of randomly presented digits was used to measure overload. As expected, the use of unpredictable, as opposed to predictable noise resulted in performance degradation on the subsidiary task. Performance on the primary task was unaffected by either type of noise. It is concluded that results reflect a reduction in spare mental capacity as a function of the aversiveness of the noise stressor.

Harcum, E. Rae & Monti, Peter M. Cognitions and "placebos" in behavioral research on ambient noise. Perceptual & Motor Skills, 1973, 37(1), 75-79.

Three experiments were conducted with undergraduates (N = 101). In Experiment I, using visual and card-sorting tasks, no effects of 100 dB ambient noise were found per se, although cognitive variables in the testing situation affected both performance and ratings of disturbance. In Exp. II and III some of the Ss were told that a noise was extraneous to their task of reproducing tachistoscopic patterns and others were told that effects of the noise were being studied. Controls received no noise. Although group membership did not affect overall perceptual accuracy, it did interact with other variables, indicating some influence on Ss distribution of attention. The "relevant" noise was rated generally less disturbing, as predicted, but with greater variance in ratings; correlations with interview data suggest that some Ss had "cooperated" with E by judging the noise to be disturbing. It is concluded that in the absence of any other adequate "placebo" to control for cognitive factors, deceptive instructions may always be necessary in studies of ambient noise.

Hartley, L.R. Performance during continuous and intermittent noise and wearing ear protection. *Journal of Experimental Psychology*,1974, 102(3),512-516.

A total of 34 housewives and 34 professional males were tested on a 5-choice test of serial reaction for 40 min. in intermittent and continuous broad band noise (Exp.I) and while wearing ear protection in continuous noise (Exp.II). Gaps in performance during intermittent noise were approximately 50% less than those in continuous noise. Errors were affected equally adversely by both intermittent and continuous noise. Ear protection interacted with noise and time-on-task, reducing gaps in noise in the first half but not the second half of the test. Results are consistent with the theory that there are 2 different effects of noise. The improvement of performance when noise was intermittent is attributed to a reduction in the monotony experienced during a long exposure to continuous noise. The value of ear protection is attributed to a reduction in perceived loudness and prevention of temporary arousal following the onset of noise.

Hartley, L.R. Effect of prior noise or prior performance on serial reaction. *Journal of Experimental Psychology*, 1973, 101(2), 255-261.

This research investigated whether the effect of high-intensity noise appears at the end of a long task because the task has been performed for some time or because the effect of noise accumulates. In a factorial study, 13 naval enlisted men performed a 5-choice serial reaction test in the last 1/2 of 40 min session or throughout the session. Noise was presented in either the 1st 1/2, the 2nd 1/2 or throughout the session. Equal duration of noise and task caused approximately equal impairment, and a whole session of noise caused twice as much impairment as 1/2 a session. Noise impairment was similar when the test was performed for either the whole or half-session. It is concluded that (a) noise has a cumulative adverse effect on performance, (b) amount of impairment is determined by duration of exposure to noise, and (c) impairment caused by noise and performance is additive.

Hartley, L. R. & Adams, R. G. Effect of noise on the Stroop test. *Journal of Experimental Psychology*, 1974, 102(1), 62-66.

Noninterference tests and two versions of the Stroop Color-Word Test were used to evaluate enlisted men's performance in loud noise and quiet. Interference and noninterference tests were performed during the first and last 10 minutes of a 30 minute exposure to noise and quiet. Interference in noise and quiet was measured by taking the difference between performance on interference and noninterference tests. 18 Ss in Exp I who were tested at both exposure durations showed increased interference in noise. In Exp II (n=32) exposure duration and practice were assessed independently. The brief exposure to noise was beneficial and decreased interference, while the long exposure increased interference, suggesting a cummulative adverse effect of noise.

Hawkes, Glenn R. Time perception research: An empirical basis for the study of attention. *Psychonomic Monograph Supplements*, 1971, 4(12), 221-224.

A brief report of ongoing research on time perception under conditions appropriate to helicopter flight is presented in the four studies described, *S*s judged .5-8 sec. intervals with backgrounds of noise (87-dB SPL), vibration, or quiet using either a production or reproduction method. The effects of response delays of 10, 20, or 30 sec.; 2-7 min. interstimulus intervals; and mental arithmetic tasks in the intervals were assessed. In all studies durations tended to be underestimated with the production method and overestimated with the reproduction method. Results support the arousal and habituation hypotheses and suggest that the habituation processes are general in nature.

Haynes, Jack R. Effects of white noise and presentation rate on serial learning in mentally retarded males. *American Journal of Mental Deficiency*, 1970, 74(4), 574-577.

Forty *S*s were given 20 trials on a serial learning task under one of four noise conditions at either a one second or four second rate of presentation. Results show that the rate of presentation was a significant factor, but not the level of noise. A significant decrease in errors was found over trials. It is concluded that learning is reduced in retarded *S*s when a fast response rate is required, and that retarded *S*s adapt rapidly to distracting stimuli if the response-rate requirement is reduced.

Houston B. Kent. Noise, task difficulty and Stroop color-word performance. *Journal of Experimental Psychology*, 1969, 82(2), 403-4.

Sixty-four undergraduates performed either a high or low difficulty Stroop color-word (CW) task or high or low difficulty color name (CN) task in a condition of either quiet (Q) or continuous noise (N). Results supported predictions that N would facilitate performance on the CW tasks, but not performance on high difficulty tasks generally. Pulse rate data taken immediately after Q or N indicated that N had not produced physiological arousal. Results are discussed in terms of an interaction between the inhibiting process involved in ignoring N and the inhibitory process involved in ignoring the conflicting uses in CW.

Houston, B. Kent Noise, negative transfer, and meaningfulness. Psychonomic Science, 1971, 22(4), 255-256.

Two studies with 32 and 48 *S*s respectively were conducted to test the hypothesis that the presence of noise, which *S*s were instructed to ignore, would facilitate performance on a negative-transfer learning paradigm but not performance on a control learning paradigm. The effect of noise on two levels of item meaningfulness for each paradigm was also studied. In both experiments, negative transfer was successfully generated for low-meaningful items and the predicted interaction between learning paradigms and treatments was obtained. In neither experiment was significant negative transfer generated for high-meaningful items, and the predicted interaction between paradigms and treatments was not obtained.

Joiner, Lee M. & Kottmeyer, Wayne A. Effect of classroom noise on number identification by retarded children. *California Journal of Educational Research*, 1971, 22(4), 164-169.

Using number recognition tasks displayed at 1/10 and 1/1000 sec. duration, the effects of 4 classroom auditory environments were examined (no noise, typical classroom background noise, typical classroom background noise and noise episodes, and noise episodes). The presence of a 1st order interaction between auditory environment and display rate support research findings indicating the suppressing effect of meaningful noise on performance. Earlier findings that the effects of noise were greatest when display durations are increased are supported.

Knirk, Frederick G. Acoustical and visual environments affect learning. *Audiovisual Instruction*, 1970, 15(8), 34-35.

The design of acoustical and visual environments can be controlled by an industrial technologist to facilitate learning tasks. The effects of background noise on cognitive, affective, and psychomotor performance range from those that are undesirable (e.g., breakdown of basilar membrane) to those that are desirable in a learning environment (e.g., masking unexpected noises that would interfere with learning tasks).

Suggestions for the control of the acoustical environment include the use of carpeting, acoustical tiling, draperies, and earth embankments along with wise geographical placement of noise-generating activities. The visual environment affects a learner's ability to perceive visual stimuli and affects his mental attitude and thus performance. It is pointed out that it is the quality of the light that matters most; the source(s) and relative contrast and color.

Kumar, P. & Mathur, C.N. Sex and Noise Distractibility. *Indian Journal of Applied Psychology*, 1969, 6, 13-4.

Forty male and 40 female graduate students were given (a) a mechanical cancellation task, and (b) a mental task involving simple arithmetic. Noise was produced by two high-pitched electric bells. It was found that with female *S*s, noise had a facilitating effect on the mechanical task and did not cause a deterioration in performance on the mental task. With male *S*s, deterioration was found in both tasks.

Mansfield, Richard Scott. Development trends in the effects of noise on problem solving. (Doctoral dissertation, Harvard University) Ann Arbor, Mich.: University Microfilms, No. 71-13263.

The purpose of the present study was to test for the development of the ability to cope with noise in problem solving. Two tasks: an auditory task and a visual task, were used to test the ability. As a test of general intelligence, the Peabody Picture Vocabulary Test was also administered. There were 30 kindergarten and 30 second grade subjects: 15 boys and 15 girls at each grade level.

For the visual task the results showed that thresholds for noise were a function of the type of problem. Kindergarteners had their highest thresholds on the discriminations with constant position. Thresholds were slightly lower on the discriminations with varying position. The lowest thresholds were on the relational problems. Second graders performed at maximum levels on both types of discrimination problems, but at significantly lower levels on the relational problems. The second graders were consistently superior to the kindergarteners. At each grade level subjects with higher IQs performed better than subjects with lower IQs. However, at the kindergarten level the superiority of the high-IQ group was more marked on the discriminations than on the relational problems, while at the second grade level the superiority of the high-IQ was apparent on the relationship problems, but not on the discriminations. Thresholds for noise on the auditory task were also higher for second graders than for kindergarteners. At the kindergarten level high auditory performance was associated with high visual performance.

Mathur, C. N. Age as a factor in noise distractibility. Manas, 1972, 19(1), 31-33.

One hundred graduate and undergraduate students worked for 20 minutes on a mental task consisting of simple arithmetical calculations under normal and noise (sound level of 80 db) conditions. It was found that the distraction was more pronounced in the age groups of 15-17 and 18-20 years than in the age group of 21-23 years.

Mowsesiah, Richard & Heyer, Margaret R. The effect of music as a distraction on test-taking performance. Measurement and Evaluation in Guidance, 1973, 6(2), 104-110.

The basic skills in arithmetic test, the differential aptitude tests, the Language Usage-Spelling Test, and Self-Concept of Ability Scale were given to 167-10th graders under 5 conditions: a control where test conditions were considered ideal and four conditions in which either rock, folk, symphonic, or operatic music was played. No differences were found on any measures regardless of test condition. It is suggested that since a variety of noises is a normal part of the environment, music is not a new experience for test takers and therefore not distracting in a test situation.

Myers, Kevin P. The effect of extraneous auditory stimuli on the performance of a complex task by disturbed and non-disturbed youngsters. Dissertation Abstracts International, 1971, 30(7-A), 2886.

This investigation assessed the effects of extraneous auditory stimuli on the performance of disturbed and non-disturbed elementary school children doing a complex learning task.

Two samples of youngsters were randomly selected from one school of a major city school system. One group attended classes for the emotionally disturbed while the other was enrolled in regular classes. These major groups were then subdivided into experimental treatments in which noise level was manipulated. A no-noise condition was also employed to serve as a comparative experimental technique.

Subjects randomly assigned to the noise condition were required to hear a tape recording of regular classroom noise through earphones while performing the learning tasks. The no-noise condition utilized the same apparatus with extraneous auditory stimuli deleted in both the original learning and relearning trials. All subjects were considered to have successfully completed the task when they could correctly identify seven of nine paired associates on two successive bloc trials.

Following a twenty-four hour period after the original learning task was completed, each subject was reexamined on the same task so that the retention rate could be ascertained. Saving scores were computed as a further measure of retention. It was concluded that neither of the main effects, presence or absence of extraneous auditory stimuli or degree of disturbance, nor the interaction of auditory stimuli and disturbance had any significant effect on original learning, relearning, and saving scores.

Nober, Linda W. A study of classroom noise as a factor which affects the auditory discrimination performence of primary grade children. Dissertation Abstracts International, 1973,33(12-A).

Thirty-nine kindergarten through second grade children were evenly divided into (1) normal, (2) speech defective, and (3) reading retarded groups, to assess their auditory discrimination performance on the Wepman Auditory Discrimination Test in both quiet and noise listenting conditions. Sound level measurements in four classrooms and four special teacher rooms in each of four schools were compared for their dBA means. Classroom means were 64.7 dBA and special teacher room means were 39.5 dBA. A tape recording of classroom noise preserving the spectral composition obtained in the four classrorms served as the noise simulation. The two sets of data, (1) the raw score number of errors and (2) the Wepman pass-fail criteria relative to errors and age, revealed comparable statistical results. Both data showed significant (p. 01) scores in quiet versus noise listening conditions; t-tests of the error scores revealed that the normal and reading retarded groups yielded the significant differences; pass-fail chi square procedures revealed that only the reading group differed significantly between the two listening conditions. The trend was always toward poorer performance in noise. Conclusion: auditory discrimination performance in quiet does not always serve as an index of functions; performance in thu relatively noisy classroom environment, especially for reading defective kindergarten through second grade children.

Rai, S.N. Effects of auditory distraction on the time estimation by the verbal estimation method. Indian Journal of Experimental Psychology, 1973, 7(1), 14-18.

Ten postgraduate students were assigned to each of two groups: a stimulus-in quiet (SQ) group and stimulus-in-sound (SS) group. The SQ group received 15, 30, 60 and 120 sec. stimulus intervals, 6 times each in random order under normal conditions (without distraction). The SS group received the same stimulus intervals with continuous 1250 CPS sound. Results show that (a) both methods of verbal estimation had different effects on time estimation for all stimulus intervals; (b) a tendency to overestimate was found both for SQ and SS conditions, but the SS condition caused more overestimation; and (c) for both conditions repeated trials had significant differential effects on time estimation, i.e. increase in trial number decreased the magnitude of error.

Renshaw, Frank M. The combined effects of heat and noise on work performance. Dissertation Abstracts International, 1973, 33(8-B), 3699.

Twelve male subjects performed at a Five-Choice Serial Reaction Task under environmental conditions of heat alone, noise alone, and heat in combination with noise. The study was divided into two exposure phases, a single-stress phase and a multiple-stress phase. Subjects in the single-stress phase experienced four levels of either heat or noise. The multiple-stress phase consisted of both single and combined exposures to different levels of heat and noise. The results indicated a detrimental effect of heat on gap scores. Subjects showed 18 percent more gaps at E.T. 90oF. than at E.T. 72oF. A detrimental effect of noise was noted in the case of total reponse scores. Subjects made 5 percent fewer responses at 90dBA than at 41dBA. Both gap scores and relative error scores revealed an interaction between the effects of moderate heat and moderate noise.

Rosenberg, Sheldon & Jarvella, Robert J. Semantic integration and sentence perception. Journal of Verbal Learning & Verbal Behavior, 1970, 9(5), 548-553.

A mixed list of semantically well-integrated (SWI) and semantically poorly integrated (SPI) sentences were presented for shadowing to 20 undergraduates under quiet and 20 Ss under noise (5-db signal-to-noise ratio). The SWI and SPI sentences were balanced for length, number, and word frequency. An incidental-recall task followed 1 trial of shadowing. As anticipated, shadowing under quiet was virtually perfect for both SWI and SPI sentences, noise reduced shadowing overall and SWI sentences were shadowed better than SPI sentences under noise. Incidental learning of SWI material was enhanced by noise, and noise produced a difference in incidental learning in favor of SWI material.

Samtur, Susan J. The effects of noise on a complex task. Graduate Research in Education & Related Disciplines, 1969, 4(2), 63-81.

This research investigated the effect of a constant or fluctuation noise on a complex reading task and considered the effect of the noise on easy and difficult problems within the test. *S*s were 25 3rd graders, 13 boys and 12 girls and the problem served as its own control. Most of the previous literature suggests that noise does affect achievement, when the task presented is difficult and long enough to permit fatigue. Results of a few studies were in contradiction to the hypothesis of this experiment and most other experiments, generally because the factors of task complexity and sustained periods of time were absent during the testing. The tests were administered under three conditions: quiet, constant noise, and intermittent noise to the same *S* group. Overall findings do not support the hypothesis. Rather the *S*s, especially the boys, did significantly better under the noisy conditions. Various explanations are considered.

Stanford, A.J. Effects of changes in the intensity of white noise on simultaneity judgements and simple reaction time. *Quarterly Journal of Experimental Psychology*,1971,23,296-303.

On the basis of earlier work and informal observation it was suspected that the effect of loudness on simple RT could not be accounted for by the changes in the time it takes the *S*s to hear the stimulus. Two experiments, each using 6 naval rating volunteers, are described in which an increment in the level of background random noise is presented to the *S*s. The effect of increment size on RT and on a simultaneity judgement are investigated using a range of increments from just above difference threshold to moderately loud and clear. The difference in the size of loudness effects in the two tasks lends some support to a model which explains the influence of loudness RT largely in terms of latency of response initiation.

Wolf, Robin H., & Weiner, Frederick F. Effects of four noise conditions on arithmetic performance. *Perceptual and Motor Skills*, 1972, 35(3), 978-930.

The proportion of correct responses by 15 female undergraduates on simple arithmetic problems was compared under four noise conditions: quiet, speech, music and industrial noise. *S*s answered a significantly higher proportion correctly under the music than under the industrial noise conditions. In all other conditions, the proportion of correctly answered responses did not differ.

MOTOR SKILLS

Studies in this section are concerned with the negative affects of noise on motor performance. A variety of phenomena are observed. Eschenbrenner (1971) showed that white noise had a detrimental effect on psychomotor performance which varied as a function of the temporal pattern and intensity of the noise. Chatterjee et al (1972) found the same effect with greater impairment of performance under intermittent than continuous noise. The same investigators found that for highly skilled Ss, continuous noise actually enhanced psychomotor performance under specific noise conditions. Perhaps providing some insight into this phenomenon, Gulian (1972) found that the negative influence of noise on performance was a direct function of task difficulty. Also, Thackray and Touchstone (1969) demonstrated that under noise conditions, Ss least proficient at the tasks suffered the greatest impairment. Cohen (1973) found that noise more adversely affected performance when the task had to be performed at a faster pace.

Another area of concern for researchers is the effect of asymmetrical noise presentation. Typical of this research is Harris (1972), which demonstrated that intermittent noise, combined with asymmetrical presentation, had a deleterious effect on equilibrium which was greater than for either variable alone.

Sommer and Harris (1970) showed that noise presented in a free-field had greater behavioral effects than similar noise presented through headphones. In this study, ability to use tools was not affected by headphone noise, but similar free-field noise did cause impaired efficiency. The same investigators (1973) also determined that when combined with vibration, 86 db noise resulted in greater performance decrements than 100 db noise. This contra-logical finding will no doubt lead to further research.

The possibility of long term learning effects was raised by Sebak and Brenk (1973). Typewriting students who learned to type under quiet conditions performed better than their counterparts under noise conditions. This difference was not observed during the learning sessions, but, rather after 50 days of no typing activity.

In another interesting experiment, Reim et.al. (1971) showed greater performance impairments after a noise was terminated when Ss had no control over its termination.

Chatterjee, Amitara & Krishnamurty, V. Differential effect of noise as environmental stress. Behaviorometric, 1972, 2(1), 1-8.

The effect of noise on performance was investigated with respect to the interaction of environmental stress and stimulation. Twenty professional typists typed for 10 minutes from predetermined materials and performance was measured by the accuracy of work done. From the results it is concluded that in psychomotor activity (a) performance is a function of skill, (b) intermittent noise acts as an environmental stress, affecting performance more than continuous noise, and (c) for highly skilled Ss continuous noise of optimum intensity may act as an arouser of performance.

Cohen, Harris H. Working efficiency as a function of noise level, work pace, and time at work. Dissertations Abstracts International, 1973, 33(8-B), 3975.

A review of the literature shows that the more obtrusive the noise and the more demanding the task, the greater is the likelihood of adverse effects of noise on task performance. A study was conducted which varied three levels of task speed or work pace (30, 40, and 50 signals/min) on a paced, serial repetitive task requiring complete and sustained attention under two conditions of aperiodic broadband noise, quiet (50 dB(A)) and noise (100 dB(A). One hour work periods were broken down for analysis into four 15-minute time blocks.

The experimental hypotheses were confirmed. Namely, (1) noise adversely affected performance on a paced, serial repetitive task; (2) the faster the work pace, the poorer was performance; (3) noise more adversely affected performance at fast work paces than at slower work paces; and

(4) performance in noise at fast work paces deteriorated disproportionately with time at work. The practical, as well as the theoretical, implications of the research are discussed.

Eschenbrenner, A. John Effects of intermittent noise on the performance of a complex psychomotor task. Human Factors, 1971, 13(1), 59-63.

Manual image-motion compensation (a complex psychomotor task involved in certain photographic activities from orbit was investigated as a function of the temporal pattern (aperiodic, periodic, or continuous) and intensity level (50,70 or 90 db.) of white noise. Ss were 24 male aircraft engineers and engineering students. Performance was measured in terms of the total amount of time image motion was held at or below a 40-microradians/sec. criteria for specific blocks of trials. Results show that white noise had a detrimental effect on image motion compensation performance, and that the magnitude of the decrement varied as a function of both the temporal pattern and intensity level of this noise.

Gulian, Edith. The factor "difficulty of the task" and its influences upon performance level under noise conditions. Revista de Psihologie, 1972, 18(3), 323-330.

A comparative analysis of performance level (amount of errors and reaction time) was conducted in three experiments under different noise conditions (quiet, weak continuous noise, and loud intermittent noise). Task difficulty was the main factor accounting for performance deterioration under noise conditions. The negative influence of noise on performance efficiency was a direct function of task difficulty. An increase in noise loudness resulted in performance deterioration according to task difficulty.

Hamilton, P. & Copeman, A. The effect of alcohol and noise on components of a tracking and monitoring task. British Journal of Psychology, 1970 61(2), 149-56.

The effects of alcohol and noise on a complex tracking and signal-detection task were examined with particular reference to changes in selective attention. Each S was instructed to give the tracking task priority. In noise, tracking performance improved, but detection of lights placed on the periphery of vision was degraded. Alcohol had the same effect on peripheral detection, but tracking performance declined. It is concluded that the effect of alcohol on such simulated driving skills embodied two factors: an increase in attentional bias towards the high priority regions of the visual field, and a decrease in the information transmission rate.

Harris, C. Stanley. Long term adaptation of pursuit rotor performance to impulsive acoustic stimulation. Aerospace Medical Research Lab Wright-Patterson AFB Ohio, 1970, Report No. AMRL-TR-73-92.

In a previous experiment, performance on a pursuit rotor task was found to adapt to impulsive acoustic stimulation by the fourth day of exposure. The purpose of the present study was to determine if performance would regain sensitivity to the stimulus after an interval of time. Six subjects who participated in the initial experiment were retested after intervals ranging from five to eight months. After a retraining day, the subjects were presented a retention test day in which the procedure was identical to that used on the four test days of the prior experiment. The stimulus (peak intensity of 112 dB with a 400 millisecond duration) was presented nine times in a semi-random fashion. The results are reported.

Harris, C. Stanley. Effects of increasing intensity levels of intermittent and continuous 1000-Hz tones on human equilibrium. Aerospace Medical Research Lab Wright-Patterson AFB Ohio, 1972, Report No. AMRL-TR-72-11.

Human equilibrium was measured during exposure to continuous and intermittent 1000-Hz tones presented both asymmetrically (one ear) and symmetrically (both ears). Intermittency combined with asymmetry produced greater decrements in equilibrium than either variable alone. The results are interpreted as a possible demonstration of acoustic stimulation of the vestibular system.

Harris, C. Stanley & Von Gierke, Henning E. The effects of high intensity noise on human equilibrium. *Aerospace Medical Research Lab Wright-Patterson AFB Ohio*, 1971, Report No. AMRL-TR-67-41.

Five experiments were conducted on the effects of broadband, high intensity noise on human equilibrium. The ability of subject to balance on narrow rails was measured during exposure to the noise; and immediately after termination of the noise. Four different noise conditions were used in each experiment: control, 120, 130, and 140 dB (re. 0.0002 dyne/sq cm). In the first experiment subjects wore earmuffs and earplugs; in the second, only earplugs were worn; and in the third experiment, subjects wore earplugs and one earmuff to produce an asymmetrical exposure. At an ambient level of 140 dB, a detrimental effect was obtained in all three experiments. At lower intensities of noise, there were performance decrements only for the asymmetrical exposure. In the remaining two experiments, conducted after termination of the noise, detrimental effects were obtained for asymmetrical auditory exposure but not for equal auditory exposure. The results of these experiments are interpreted as a possible quantitative demonstration of the direct effect of high intensity noise on the vestibular system.

Harris, C. Stanley & Schoenberger, Richard W. Combined effects of noise and vibration on psychomotor performance. *USAF AMRL Technical Report*, 1970, 70-14, 24 p.

Tracking perfromance and RT of highly trained Ss to the appearance of a red light and disappearance of a green light were measured during four experimental conditions: 2 conditions of 85- and 110- dB broadband noise exposure, and 2 in which these noise exposures were combined with .25g vertical vibration at 5 Hz. Duration of exposure for each condition was 19 min. Vibration had an adverse effect on both the horizontal and vertical dimensions of the tracking task and on RT to both sets of lights. Noise had a significant effect, both with and without vibration, but only on the vertical part of the tracking task. On vertical tracking, the detremental effect of noise was additive to that of vibration when both noise and vibration were presented simultaneously (110-db noise and .25 g vertical vibration at 5 Hz.).

Harris, C. Stanley, & Sommer, Henry C. Human equilibrium during acoustic stimulation by discrete frequencies. USAF AMRL Technical Report, 1968, 68-7, 1-11.

The ability of 48 male undergraduates to balance on narrow rails was measured during exposure to pure tones of 100, 260, 590, 1500 and 2500 Hz and a control condition. Group 1 was presented the test stimulus at intensity levels of 95 dB in the left ear and 75 dB in the right ear (asymmetrical exposure). Group 2 was presented the tones at a level of 95 dB in both ears (symmetrical exposure). A decrement in rail performance occurred at 1500 Hz for Group 1 and at 590 Hz for Group 2. The decrement with symmetrical exposure was less than the decrement found with asymmetrical exposure. Results support previous findings that asymmetrical exposure has more adverse effects on human equilibrium than symmetrical exposure. Both frequencies at which decrements occurred were found to have the lowest threshold for vestibular system.

Heimstra, Norman W. Research on intermittent noise effects on Air Force target detection tasks. South Dakota Univ. Vermillion Dept. of Psychology, 1972, Final Report, 51 p.

The report discusses how noise influences performance in complex and unpredictable ways. Variables associated with the sound itself as well as task variables are seen to determine the effects on performance. In addition, subject variables are also noted. The investigations were concerned with the relationship between variables in the several categories and performance on a variety of types of target detection, vigilance, and psychomotor tasks.

Hockey, G. R. Effect of loud noise on attentional selectivity. Quarterly Journal of Experimental Psychology, 1970, 22(1), 28-36.

The effects of loud noise were examined by observing its influence upon a combined tracking and multisource monitoring task. Ss were 12 naval ratings who showed satisfactory audiometric performance. Tracking improves in noise, as does the detection of centrally located signals in the monitoring task. Peripheral signals are detected less often in noise. Data are interpreted in terms of increased selectivity of attention with arousal.

Hornbuckle, Phyllis A. Delayed response performance as a function of sensory stimulation in the squirrel and owl monkeys. Dissertation Abstracts International, 1969, 30(6-B), 2440.

A comparative study of delayed response performance in squirrel and owl monkeys was carried out. The effect of light vs. dark and noise vs. quiet on DR performance was assessed. Squirrel monkeys were found to perform better in the dark than in the light, while owl monkeys performed better in the light then in the dark. Both species made more errors in the noise than in quiet. These results were explained in terms of increased neural activity reflecting the relative effect of these sensory conditions on the activity of the reticular formation. Errors and reaction time were observed to increase as delay intervals increased. Reaction time was found to decrease as errors increased under light conditions for squirrel monkeys and was found to increase as errors decreased under light conditions for owl monkeys.

Lambert, Sue E. The effect of white noise and rest interval on pursuit rotor learning in retardates. Dissertation Abstracts International, 1971, 30(12-A), 5312.

It was the purpose of this experiment to compare several characteristics of pursuit rotor learning in a retarded population to see if hypotheses based on a consolidation of memory theory have relevance for retardate's learning of a motor skill. White noise having been found to effect retention in verbal learning experiments with normal Ss and thus appearing to act as an arousal mechanism was used to see if it would effect motor learning in a retarded population. 120 mentally retarded Ss in the public schools were randomly assigned to treatment groups. Two experimental groups were given a programmed rest of 10 minutes between continuous massed practice trials of five and fifteen minutes. Two other experimental groups had a 24-hour rest between learning trials. One 10- minute and one 24-hour group had white noise administered during the three to six minute intervals after five minutes of massed practice.

The only variable having effect on postrest performance was a level of prerest performance. None of the hypothesized differential effects of length of rest intervals or white noise was obtained.

Munz, D.C., Ruffner, J.W. & Cross, J.F. Reduction of noise annoyance through manipulation of stressor relevance. *Perceptual and Motor Skills*, 1971, 32(1), 55-58.

In order to test the merit of considering noise from an informational viewpoint, 30 undergraduates were randomly assigned to either a high task-involvement (HTI) on low task-involvement (LTI) instruction group and performed pursuit rotor tracking under 3 conditions of moderate noise stress: task-related noise, task-unrelated noise, and no noise. No performance effects were evidenced. However, HTI *S*s reported experiencing greater psychological discomfort under task unrelated noise as compared with the other two noise conditions. Moreover, comparisons of postexperimental rankings of working condition preference supported this finding.

Murphy, E. H. & Venables, P. H. The investigation of ear asymmetry by simple and disjunctive reaction-time tasks. *Perception & Psychophysics*, 1970, 8(2), 104-106.

In a disjunctive RT task in which 20 college students responded to clicks presented to one ear while white noise was presented to the other, RT was significantly faster to stimuli presented to the left than the right ear. In a simple RT task, using the same stimuli, there was no difference in RT to stimuli presented to right or left ear with 20 *S*s. Results are discussed in relation to functional asymmetry of the cerebral hemispheres, and a perceptual interpretation of the ear asymmetry effect is supported.

Nosal, C. Effect of noise on performance and activation level. *Polish Psychological Bulletin*, 1971, 2, 23-29.

The influence of noise on detection of visual signals was investigated in two conditions: with noise (90 db.) and without noise. RT,GSR, and the Ss evaluation of his RT were measured. Results are interpreted in terms of the Yerkes-Dodson law. In the noise conditions, both simple RT and GSR increased significantly ($p < .001$). The correlation between RT and GSR was positive and statistically significant in the noiseless condition ($r = .296$, $p < .05$) and not significant in the noise condition.

Reim, Bruce, Glass, David C. & Singer, Jerome E. Behavioral consequences of exposure to uncontrollable and unpredictable noise. Journal of Applied Social Psychology, 1971, 1(1), 44-56.

Behavioral consequences of exposure to high-intensity predictable and unpredictable noise was investigated under conditions where Ss did or did not believe they had control over noise termination. Ss were a group of men and women, averaging 50 yr. of age, who had lived in an urban environment for most of their lives. Results showed that the work of adapting to uncontrollable, in contrast to controllable noise, produced greater performance impairments following termination of the noise. Predictable noise had minimal effects on postadaptive performance, even though Ss could not control its offset. Comparisons of these data with previous findings indicate that people living in urban settings for long periods of time show essentially the same negative consequences of noise adaptation as those living in cities for shorter durations.

Sanford, A.J. Effects of changes in the intensity of white noise on simultaneity judgements and simple reaction time. Quarterly Journal of Experimental Psychology, 1971, 23(3), 296-303.

On the basis of earlier work and informal observation it was suspected that the effect of loudness on simple RT could not be accounted for by changes in the time it takes the S to hear the stimulus. Two experiments, each using 8 naval rating volunteers, are described in which increment in the level of background random noise is presented to the S. The effect of increment size on RT and on a simultaneity judgement are investigated using a range of increments from just above difference threshold to moderately loud and clear. The difference in the size of loudness effects in the 2 tasks lends some support to a model which explains the influence of loudness in RT largely in terms of latency of response initiation.

Sebek, Levin & Brenk, Klas. Influence of noise on the degree of development of typewriting skill. *Revija za Psihologije*, 1973, 3(1-2).

Two groups of 10 *S*s each were trained in typewriting for a period of 32 training sessions. The training period was broken for 50 days after the first 16 sessions. One group of *S*s worked in normal acoustical conditions while the other was exposed to a continuous noise between 68 and 71 db. The learning curves of the two groups, determined on the basis of number of letters typed in a one minute period, did not differ during the first 16 sessions. After the 50 days break, a difference between the two groups appeared. This difference was in favor of the group which learned in normal conditions and increased during the further training sessions, being maximal at the end of the training period. The difference is ascribed to "degeneration of engrams" and poorer central organization of motor activity-defects which can appear only after a longer period of inactivity.

Simon, J. Richard, Craft, John, and Small, A. M. Manipulating the strength of a stereotype; Interference affects in an auditory information- processing task. *Journal of Experimental Psychology*, 1970, 86(1), 63-68.

In a choice RT task, 96 undergraduates pressed either a right- or left-hand key in response to monaural "right" and "left" commands conveyed by 200- and 500-Hz, 96-dB SPL tones. Commands were either presented alone (no-noise trials) or accompanied by a broad-band noise to the same or opposite ear. On the no-noise trials, RT was significantly faster when the meaning of the command corresponded to the ear in which it was heard than when it did not. This Tonal Command * Ear Stimulated interaction was eliminated, reduced, or reversed by manipulating the noise intensity at the opposite ear, and was accentuated by introducing accompanying noise to the same ear. Results are explained in terms of a potent natural tendency to react toward the major source of stimulation.

Sommer, Henry C. & Harris, C. Stanley. Comparative effects of auditory and extra-auditory acoustic stimulation on human equilibrium and motor performance. USAF AMRL Technical Report, 1970, 70-26, 16 p.

Human equilibrium and psychomotor performance of 22 Ss exposed to free-field broadband noise (140 dB) or a similar spectra of noise presented through earphones were compared. Approximately twice as much decrement in equilibrium was obtained for Ss exposed to free-field noise with earplugs and muffs, and earplugs alone than was obtained from Ss who received comparable auditory exposures through earphones. Four times as much decrement was obtained for Ss who received an asymmetrical exposure condition when free-field performance was compared to the earphone condition. Similarly, the ability to perform with ordinary mechanic tools was adversely affected by free-field noise and unaffected by noise presented through earphones. Auditory stimulation combined with extra-auditory acoustic stimulation produced much more decrement in human equilibrium and motor performance than auditory stimulation alone.

Sommer, Henry C. & Harris, C. Stanley. Combined effects of noise and vibration on human tracking performance and response time Aerospace Medical Research Lab Wright-Patterson AFB Ohio. 1973, Report No. AMRL-TR-72-83.

Vibration has been shown to be the primary cause of performance impairment in studies of the combined effects of noise and vibration on human tracking performance. Noise has had little consistent effect when presented alone, and has added little or not at all to the impairment produced by vibration. In two studies with heat included as a third stressor, vibration presented alone had a slightly more adverse effect on tracking performance than combined heat, noise and vibration. In the present experiment, 12 subjects were exposed to lower noise and vibration levels for a longer period of time than used previously. Noise had no significant effects on tracking performance, while vibration adversely affected both dimensions of the tracking task. On both horizontal and vertical tracking, vibration combined with 60 dB noise produced greater impairment than vibration combined with 100 dB noise. These results parallel previous findings from studies of combined noise, heat, and vibration, and give support to a subtractive interaction interpretation of the combined effects of noise and vibration on human tracking performance.

Takasawa, Noriyoshi. Tapping under the condition of white noise presentation. *Journal of Child Development,* 1973, 8, 23-41.

Tested the effect of white noise on the motor performance of 110 male The effect of white noise on the motor perfromance of 110 male undergraduates during a tapping task was investigated. Three degrees of white noise Tapping pressure was measured as the index of behavioral activity level, and GSR as that of autonomic activity. Tapping pressure increased in correspondence to the intensity of white noise. This phenomenon is discussed in terms of arousal.

Thackray, R. I. & Touchstone, R. M. Recovery of motor performance following startle. *FAA Office of Aviation Medicine Report*, 1969, 69-21, 11 p.

Following training of 30 *S*s on RT and tracking tasks while recording heart rate and GSR, startle stimuli (noise) were presented during performance. Performance recovered within 15 sec. and startle RTs were shorter than those for nonstartle stimuli. *S*s least proficient in performance showed the greatest increase in error and reacted most strongly to the startle stimuli.

Thornton, Jerry W., & Jacobs, Paul D. Analysis of task difficulty under varying conditions of induced stress. *Perceptual and Motor Skills*,1970 31(2), 343-346.

Two tasks (simple and choice RT) were examined while varying 3 types of stressors (shock, threat of shock, and noise) and the stressor task relationship (i.e., task related stress, task-unrelated stress, and no-stress). *S*s were 36 undergraduates. Four hypotheses were tested and 3 were supported in the simple RT task. There were no significant differences among stressors for either task, although greater differences were reported in the simple than in the choice RT task. A significant difference between the task-relatedness of stress levels in the simple task was interpreted as possibly due to a coping or protective adaptive mechanism in which increases in performance serve to reduce stress. Practical applications are examined.

PHYSIOLOGICAL EFFECTS

Research over the past four years related to the physiological effects of noise encompasses a broad range of investigative areas and a diversity of responses. It is possible however to comment on several coherent areas. For example, studies dealing with the attentional and arousal effects of noise indicate that subjects exposed to noise show GSR adaptation whereas similar adaptation does not occur to electric shock stress (Stern, Gaupp and Leonard, 1970). Stability of Rod and Frame Test performance and amount of EEG alpha are not affected by noise (Hayes and Venables, 1970). Williams, Wells and Lowe (1971) found that response rate to a light reinforcement in rats was depressed in a noise environment. A number of studies since 1970 purport to show the effects of noise on clinically important physiological variables. Jansen (1971) concludes that medical evidence clearly shows that autonomic habituation to noise does not exist. Experiments with humans and animals show that noise can affect the autonomic control of blood circulation, metabolism, and can also attack the pituitary-adrenal cortex system (Grandjean,1971). Eosinophil levels in the blood drop after acoustic fatigue (Amorella,1971). Semczuk (1971) found that supraliminal acoustic stimuli (pure tones) markedly change respiratory movements and elicit no adaptation. Increases in urinary catecholamines, free fatty acids in blood plasma and adrenal weights have been reported (Hrubes and Benes, 1971), in response to noise environments along with increased oxygen consumption, reduction in the concentration of adrenol catecholamines, and reduced resistance to acute hypoxia (Dadidovic, Debijadi, Elcic and Dadinovic, 1971). Udalov, Lapoco and Syzrantsev (1971) report that administration of vitamin therapy, and glutamic acid limit the damaging effects of noise on flying perconnel. Further, Raskin, Kotses and Baver (1969) demonstrated changes in pulse amplitude (decrease), skin blood content (increase) and heart rate (acceleration). Loss of cerebral capacity to react to different impulses in noise environments is reported by Strakhov (1968).

Of the research abstracts cited two allude to potential noise and stress effects of vital importance. Getsel and Alekseev (1970) have demonstrated lasting disturbances in the blood-brain barrier permeability and metabolism of macromolecular phosphoric compounds due to the effects of noise. Also, Lown, Verrier and Corbalan (1973) have produced a reduction in the threshold for ventricular fibrillation in the dog as a result of the psychological stress associated with the administration of shock.

Adreeva-Galavina E. Ts, Alekseev, S.V., Suvrov, G.A. Kadzslin, A.V.
On the problem of the mechanism of noise-action on the organism.
Vestrik Akademii Meditsinskikh Nauk SSSR, 1969, 24(3), 11-18.

Twenty, 25 year old human Ss and laboratory animals (rabbits, guinea pigs, rats, mice) were employed in a study of the unfavorable effects of noise on the organism, employing "reflexometry, determination of concentration of attention, EEG, EKG, autoradiography, pulsotachometry, taxooscillography, determination of summated threshold indices, integral methods (determination of oxygen consumption, changes in weight of internal organs, muscular strength, and total weight), and histological methods". Under the action of noise with the intensities and spectral composition employed, (1) changes occurred in the equilibrium, strength, and lability of the nervous processes, (2) lengthening of the latent period of the the CRs occurred, (3) differentiations were lost, and (4) concentration of attention was reduced. The noise applied produced marked changes in the bioelectric activity of the cerebral structures investigated, depending on the parameters of the stimuli. In phase 1 (active) there was a predominance of low amplitude frequency activity in the bioelectric picture of the cortical regions (auditory, occipital, sensorimotor) and the subcortical regions (mesencephalic reticular formation, pons Varolii, non-specific thalmic nuclei). Excited behavior accompanied the active phase which was followed by the development of phase 2 (passive) characterized by sleepiness and sluggishness. Neuropharmacological drugs, which selectively enhance and depress the adreno and cholinoreactive systems of the brain, produced evidence that in the 1st period under the influence of noise the functional activity of the structures of the brain was enhanced, but in the 2nd period sharply reduced.

Amorelli, A. "Contribution to the study of the effect of acoustic stimulation on the blood eosinophil count. *Army Foreign Science and Technology Center Charlottesville Va.*, 1971, Report No. FSTC-HT-23-257-71.

The writers report the findings of an investigation of variations in peripheral hematic eosinophil levels in 20 subjects with normal hearing. They advance the hypothesis that a combined acoustic-hypothulmic-pituitary reflex is involved in determining a drop in eosinophil levels in the blood after acoustic fatigue, and that it is analogous to the optical-hypothalamic-pituitary reaction to light stimulus.

Arnal, D. & Gerin P. Study of the residual noise of average evoked potentials. *Electroencephalography & Clinical Neurophysiology*, 1969, 227(3), 316-321.

An experimental study of the evolution of the signal-noise ratio during summation and of the residual noise at the end of summation is described. Results were: (a) the description of the alpha rhythm which agreed best with the results was that of narrow band noise in which the central frequency fluctuated slowly in a random fashion; (b) the method of random summation proposed by D.S. Ruchkin was valuable to obtain better extraction of the short-term noise but proved useless in the long term; (c) only the components of the averaged evoked potentials with amplitudes greater than twice the standard deviation of the residual noise were significantly different from the background noise; (e) applying the above criteria to 100 *S*s, significant late oscillatory responses were seen in 30% of the *S*s with the eyes closed but in no *S* with the eyes open; and (f) a simple practical way of measuring 4 times the standard deviation of the residual noise is proposed.

Ashton, R. The effects of the environment upon state cycles in the human newborn. *Journal of Experimental Child Psychology*, 1971, 12(1), 1-9.

The effects of increased ambient noise level or decreased illumination level upon the postprandial state cycles of the neonate are investigated.

Forty-two full-term, healthy neonates served as Ss. Only the dimmer light condition had any effect, stabilizing the respiration rate per minute over Ss, irrespective of state, and significantly lowering the mean respiration rate in epochs of either alertness or active sleep. Increased level of ambient noise had no such effect. Neither environmental change significantly affected the cycling of the states in the postprandial period nor the mean heart rate per minute of the babies. A simple explanation for positive effect of the dim-light condition is offered.

Atherly, G.R., Gibbons, S.L. & Powell, J.A. Moderate Acoustic Stimuli; The interrelation of subjective importance and certain physiological changes. Ergonomics,1970, 13, 536-545.

A preliminary stufy was conducted with 14 male and 14 female Ss to determine the interrelation between moderate stimulation and certain physiological changes. It was shown the "subjective importance" of the noise was a material factor effecting changes in skin resistance. Further studies were made of the effect of whole day exposure to aircraft, typewriter, and white noise. The noises of high subjective importance (the aircraft and the typewriter) both showed measureable physiological changes, whereas that of low subjective importance (white noise) showed no significant change compared with control levels. Estimations from 4 university staff Ss with sedentary occupations showed a marked decrease in 24 hour urinary 17 ketosteriod and eosinophils, and an increase in total white cell count, lymphocytes, and neutophils. It is suggested that moderate noise does not act as a conventional stresser and that it may result in a characteristic syndrome which is comparable with a mild form of anxiety-depression.

Becker, R.W., Poza, F. & Kryter, K.D. A study of sensitivity to noise. Stanford Research Institute Menlo Park California, 1971, Final Report, 65 p.

In the study, 140 subjects were exposed to simulated sonic booms and recorded residential noises in one, two, or three two-hour sessions over a period of six months. Electrophysiological measures of heart rate and electromyographic responses to the stimuli were analyzed. Biographical, demographical, and personality inventories were also obtained for each of the subjects. The purpose of this research was to: determine whether there are different degrees of psychological and physiological sensitivity to noise in a large group of people; to determine whether and how such sensitivity varied in time; and to relate such sensitivity to other psychological and personality variables. Significant differences in psychological sensitivity to noise were found in the subject population. These differences remained stable for the duration of the experiment and were also found to be related to the attitudinal and belief structures of the individuals. Definite physiological responses to the simulated sonic booms were observed. However, the physiological indices used in this research did not show individual differences in physiological sensitivity to noise. These results do not preclude the possibility that more elaborate and extensive psychophysiological measurements might demonstrate varying physiological sensitivity to noise.

Brackbill, Yvonne Continuous stimulation and arousal level in infants: additive effects. Proceedings of the Annual Convention of the American Psychological Association. 1970, 5(pt.1), 271-2.

This research attempted to determine whether level of arousal decreases as an inverse function of the number of sensory modalities continuously stimulated. Ss were one anencephalic infant and 24, one month old normal infants who served under five different conditions: no extra stimulation (control condition) and continuous stimulation of 1,2,3, and 4 sensory modalities. The four types of stimulation were auditory, visual, proprioceptive-tactile (swaddling), and temperature. Indices of arousal level included heart rate, respiration, regularity, and gross motor activity.
Results: (a) reaffirmed the pacifying effect of continuous stimulation, (b) indicated that the effect is not restricted to one sensory modality but is instead a general characteristic of sensory stimulation in early development, and (c) demonstrated that the pacification effect is indeed cumulative across modalities.

Putukhanov, V.V. Reflectory bioelectric response of skeletal muscles to the pulse noise. Fiziologicheskii Zhurnal SSSR, 1971, 57(4), 566-574.

Noise pulses of 30/min frequency and 80-, 90-, and 100-db intensity, were given during 60 sec. Increase in frequency and amplitude of the skeletal muscle bioelectrical activity was noted. The maximum value of potentials in the muscles was obtained after 5 sec. of stimulation. The noise pulses of different intensity caused different reflexes. The maximum value of action potentials in the m. masseter, m. latissimus dorsi, and m. rectus abdomini was observed after the influence of 90-db noise, and in the m. biceps, m. triceps, m. tibialis ant., and m. gastrocnemius after 100-db noise. Switching off of the stimulation was accompanied by a stepwise decrease in the parameters of the electrical activity: it returned to the initial level or was near it in 15 sec. During stimulation, the action potentials increased in all muscles. The frequencies of groups of potentials and noise pulses were identical.

Cheuden, H.G. The masking noise and its effect upon the human cortical evoked potential. Audiology, 1972, 11(1-2), 90-96.

Both white and narrow-band noise were used as monaural stimuli to record cortical evoked potential from normal hearing adults with different intensities of stimuli. With such stimuli, the N1 peak of the response was prolonged in comparison to the response to the onset of a pure tone. The effect of simultaneously stimulating 1 ear with a burst of pure tone and the other with noise such as might be used for masking the contralateral ear was also studied. In this situation, the N1 peak in response to the tone usually showed the amplitude that was to be expected if only the pure tone had been given without contralateral masking. The response to pure tones of various intensity levels in the presence of contralateral noise at a steady intensity was also measured.

Clopton, Ben Michael Behavioral and neural aspects of increment detection by monkeys for the intensity of wide-band Gaussian noise. (Doctoral dissertation, University of Washington) Ann Arbor, Mich.: University Microfilms, No. 70-14744.

The object of this research was to further define the auditory decision process behaviorally and neurophysiologically. The psychophysical behavior of monkeys was analyzed according to the suggestions of signal detection theory in order to better characterize the behavior and provide a structured context for neural investigations.

Rhesus monkeys were trained to detect a 100-msec. increment in the intensity of a continuous Gaussion noise. The task was analogrus to the "yes-no" task used with humans. It required a differertial response on one of two bars every trial, reinforcement being contingent on the response and whether the increment occurred or not. The behavior of the monkeys was consistent with the expectations of signal detection theory in that observer sensitivity and response bias were descriptive of the results and amenable to experimental manipulation. The results were compared to the predictions of a specific detection model or "ideal observer" based on characteristics of the physical stimulus. Although qualitative agreement was demonstrated by this comparison, the quantitative discrepancies suggested further modification of the model to more closely parallel the animals' behavior. The animal observers were somewhat less sensitive than human observers in similar tasks. Suggestive patterns in the response latencies were consistently found and may reflect importantly on the nature of the auditory decision process.

After the behavioral phase, electrodes were implanted bilaterally at the inferior colliculi and auditory cortex and unilaterally at other cortical sites. Field potentials recorded at the inferior colliculus during the task reflected stimulus information only. They were not predictive of the animal's response. It proved possible to replace the peripheral stimulus to be detected with stimulation at the inferior colliculus and auditory cortex through the same electrodes. Stimulation outside the auditory pathway was ineffective. Central stimulation used to condition the peripheral stimulus predominantly produced changes of response bias. These neurophysiological results suggest neural processing arrangements which incorporate biasing as a separate aspect of the auditory decision process..

Cohn, Robert. Differential cerebral processing of noise and verbal stimuli. Science, 1971, 172(3938), 599-601.

Psychophysiological measurements have indicated that the right cerebral hemisphere processes noises and other nonverbal data and that the left processes verbal material. Results of a study with 37 Ss with clinically normal auditory acuity, indicate that direct physiological measurements, as expressed in summated auditory evoked cortical responses, demonstrate that click noises show a greater amplitude of initial output over the right brain, and that verbal stimuli produce either equal or higher amplititudes of output over the left cerebral hemisphere.

Dadidovic, Jovan; Debijadi, Rudi; Elcic, Stojanka & Dadidovic, Vukosava. * Effect of noise on resistance to acute hypoxia. Army Foreign Science and Technology Center Charlottesville Va., 1971, Report No. FSTC-HT-23-276-71.

Studies were undertaken in order to obtain more detailed information on the relation between noise and the tolerance to hypoxia. The following conclusions were drawn: Exposure of animals to intense acoustic trauma of 115-120 decibels (frequency -- 800-1,100 cycles per second) causes increased oxygen consumption. The same intensity of auditive stimulation causes a significant reduction in the concentration of catecholamines in the adrenal glands. Previous exposure of animals to the described level of noise for one hour daily on six successive days or for a total of only one hour considerably reduces resistance to acute hypoxia induced by a simulated altitude of 12,000 meters.

DeSchriver, Richard Lee. The effect of noise upon the instrumental performance of exercised and non-exercised rats. (Doctoral dissertation, University of Minnesota) Ann Arbor, Mich.: University Microfilms 1969, No. 60-20,009.

The purpose of this study was to determine if the treatment of swimming and/or noise would produce an increased capacity to instrumentally respond during exposure to noise.

Procedure

Sixty 75 day old male Sprague-Dowley rats were randomly divided into a control group and four treatment groups: 1) 6 wks. exercise, 2) 6 wks. exercise + noise, 3) 3 wks exercise + noise, and 4) noise.

All subjects learned a Skinner box bar-touching response under a condition of 23 hr. food and water deprivation. When the rat touched the bar, the investigator depressed the bar causing a delivery of 20% sugar solution.

The forced swimming treatment consisted of ten 8 min. swims, eleven 10 min. swims, and forty 12 min. swims for the two 6 wks. exercise groups. The 3 wks. exercise + noise control groups were not swum.

During the final twenty-nine treatment sessions, the 6 wks. exercise + noise groups were exposed to an intermittent 90 decibel white noise while swimming. The 6 wks. exercise and the control groups were not exposed to noise.

Post treatment performance was assessed by two 5 min. Skinner box tests administered 24 hrs. apart and under a condition of 23 hr. food and water deprivation. During both tests, the rats were exposed to an intermittent 100 decibel white noise signal. The subjects received a 20% sugar solution reward by means of the previously learned bar-touching response.

The following measures were obtained: 1) latency and reciprocal latency of the initial bar-touch, 2) number of bar-touches for each 1 min. test interval and 3) total number of bar-touches.

Body weights were recorded at 80, 105, and 107 days of age. The 6 wks.

exercise group swam to exhaustion at 87 and 106 days of age. All groups swam to exhaustion at 134 days of age. Immediately following sacrifice, the adrenal glands were weighed.

Statistical Analysis

Between group means were compared by a one-way analysis of variance. Within group mean comparisons were tested by a randomized block, two-way analysis of variance. Posterior analyses were accomplished by either orthogonal contrasts or a Newman Keuls test.

Relationships between the variables were determined by the Pearson-Product Moment Correlation Coefficient.

Results

Between group differences in the speed of the initial bar-touch and the rate of bar-touching for the two 5 min. Skinner box tests were not statistically significant. Compared to the control group, the mean number of bar-touches for each of the four treatment groups tended to be greater during each 1 min. interval and for the total test.

A general pattern of statistically significant within-group rate of bar-touching improvement between the two 5 min. tests was found for all groups. Significant probabilities ranged from .05 to .001 among the five groups for twenty-six of the thirty possible rate measures.

The two 6 wks. exercise groups had statistically significant lower body weights at 105 and 127 days of age ($p<.001$). The swim times of the six wks. exercise groups were significantly lowered during the experiment ($.01<p<.025$). No statistically significant between-group differences were found for swim times at 134 days of age, adrenal weights, or adrenal weight-body weight ratios.

Generally, the behavioral variables did not correlate with body weight, swim time, or adrenal weight.

Implications

Although between-group comparisons of the Skinner box variables were non-significant, the elevated level of instrumental performance by the treatment groups is of interest. The facilitating effect of the noise treatment was expected. However the indication that swimming may have promoted improved instrumental responding during noise exposure, as evidenced by the 6 wks. exercise group, is noteworthy and suggestive of a possibly unique outcome for exercise.

Dinsmoor, James A., Bonbright, James C. & Lilie, Daniel R. A controlled comparison of drug effects on escape from conditioned aversive stimulation ("anxiety") and from continuous shock *Psychopharmacologia*, 1971, 22(4), 323-332.

The effects of chlordiazepoxide and chlorpromazine on the response of 6 squirrel monkeys exposed to alternating stimuli of (a) continuous shock at a lower intensity were compared. A variable interval schedule of stimulus termination was used. It was found that chlordiazepoxide (2.5-10 mg/kg,ip) produced a significantly greater decrease in response rate under the continuous shock condition than with noise. The fact that previous findings of selective action with this drug reflect uncontrolled factors (e.g, differences in reinforcement contingencies or in escape and avoidance responding).

Dresher, Dennis G. Noise induced reduction of inner ear microphonic response: Dependency on body temperature. *Science*, 1974, 185, 273-274.

The rate of reduction of chinchilla cochlear microphonic response with exposure to steady noise is less at lower body temperatures and greater at higher body temperatures. Before exposure to noise, this auditory response is invariant within the range of temperatures employed. The mechanism of reduction of cochlear response appears to involve processes sensitive to body temperature.

Dumkina, G.Z.*Some clinical and physiological studies of workers subjected to stable noise. *Army Foreign Science and Technology Center Charlottesville Va.*, 1973, Report No. FSTC-HT-23-2405-72.

Machine operators studied, subjected to the influence of middle and high frequency noise at 85-99 dB, showed functional changes in the nervous system characteristic for the astheno-vegetative syndrome. The degree and frequency of these changes increased with increasing noise intensity and working experience under the influence of noise. A number of persons, with no organic changes in the cardiovascular system, showed functional changes of hemodynamics, manifested as cardiac-type complaints, lability of blood pressure and tendency toward capillary spasm. In some cases, a persistent reduction in auditory sensitivity was noted in the high frequency range, progressive with increasing noise intensity and work experience.

Feldman, Shoul & Dafny, Nachum. Acoustic responses in the hypothalmus. *Electroencephalography and Clinical Neurophysiology*, 1968, 25(2), 160-9.

Evoked potentials and single cell responses were recorded in the hypothalmus of 31 cats following acoustic stimulation. The possible pathways involved in the propogation of the acoustic responses to the hypothalmus are reviewed and factors modifying the sensory input to the hypothalmus are discussed.

Fichtel, K. On the features characterizing the elaboration of vasodilational conditioned responses in man. *Fiziologicheskii Zhurnal SSSR*, 1970, 56(4), 610-7.

*S*s were 8, 16-38 year olds. A biphasic thermovascular response was evoked by utilizing arm baths of increasing temperature: a vasoconstrictive phase for temperatures of 32-34°C, followed by a vasodilational phase for higher temperatures. Combining such arm immersions with prolonged acoustic stimulation in the form of tape-recorded music, it is possible to elaborate a vasodilational CR to a stimulus eliciting initially an orienting vasoconstrictive reaction. An odd byproduct of the study was the finding that the music, itself, exhibited a vasodilational effect.

Furedy, John., et al. Preparatory-response vs information-seeking interpretations of preference for signaled loud noise: Further limits on human informational cognitive control. *Psychonomic Science*, 1972, 27(2), 108-110.

A series of .3-sec noises of varying intensity (80,90,100,110, or 120 dB were presented to 56 undergraduates. One half the noises were preceded by an 8-sec signal. A postexperimental questionnaire indicates a reliable group preference for signaled over unsignaled noise. A preparatory-response interpretation of the preference would require the presence of informational cognitive control, defined as occurring whenever the signal reduces the subjectively-rated intensity of a noxious inescapable outcome. No such reduction was observed, even though the subjective intensity ratings were clearly sensitive to physical noise-intensity differences. Results are consistent with an information-seeking interpretation of the preference-for-signaled-noise phenomenon.

Getsel,KH.A. & Alekseev, S.V. The permeability of blood-brain barrier to radio active phosphorus and the phosphoric metabolism in cerebral structures of wistar rats under the influence of noise. *Fiziologicheskii Zhurnal SSSR*, 1970, 56, 1758-66.

Employing the quantitative autoradiographic method, disturbance in the blood-brain barrier permeability were shown to disappear 24 hours after a single application of noise. Lasting disturbances in the blood-brain permeability and metabolism of the macromolecular phosphoric compounds due to the multiple effect of noise in *S*s were also shown.

Giannitrapani, Duilio. EEG changes under differing auditory stimulations. *Archives of General Psychiatry*, 1970, 23(5), 445-453.

Amplitude changes and phase angle relationships were investigated between 16 brain areas for frequencies from 1-33 cps. *S*s were 32, 11-14 yr. old right-handed boys. Besides two resting control periods, 3 auditory conditions were used, one unpatterned (white noise), a musical excerpt, and a story. The three conditions showed similarities in the patterning of EEG data and distinctive features characteristic of each condition.

Similarities consisted of amplitude changes primarily in the prefrontal-to-occipital and homologuus temporal comparisons. The noise condition was characterized by left temporal increase in beta activity and anterior leading of alpha in the left prefrontal-to-occipital comparison. Music was characterized by the smallest change in amplitude from resting, bilaterally symmetrical loading in the prefrontal-to-occipital comparisons, and anterior leading in the left central-to-occipital comparison. Voice was characterized by a bilateral increase of beta activity in the temporal areas and posterior leading of alpha in the left prefrontal-to-occipital comparison. Both the music and voice test conditions showed a decrease in the left leading activity characteristic of the resting condition in this right-handed group, but in slightly different beta frequency bands. Findings, indicate both the specificity and the generality of the mediation of auditory processes in the human brain.

Glaser, Edmund M. Cortical responses of awake cat to narrow-band FM noise stimuli. Journal of the Acoustical Society of America, 1971, 50(2, Pt. 2), 490-501.

Four female unanesthetized cats were stimulated with chronically emplanted epidural electrodes in the region of primary auditory cortex with FM noises of varying bandwidths. The average evoked responses were compared with responses to tone bursts of the same center frequency and intensity. It was found that (a) the magnitude of the early response components increased with the bandwidth of the modulating noise, the relationship being fitted well by a power funcion; (b) there was a smaller power-law type of increase in response amplitude with RMS rate, noise bandwidth being held constant; and (c) responses to transitions from tone to noise were quite marked, often exceeding burst responses, while responses to transitions from noise to tone were only rarely observed. Results are discussed in terms of the activity of single units in auditory cortex. A simple neuronal model is proposed to explain and unify the findings. Findings are compared with phychological loudness summation studies.

Grandjean, Etienne. "Physiological and psychophysiological effects of noise. *Army Foreign Science and Technology Center Charlottesville Va.*, 1971, Report No. FSTC-HT-23-239-71.

Present knowledge of the physiological and psychophysiological effects of noise is reviewed. Experiments with animals and humans show that noise stimuli can effect the autonomic control of blood circulation, metabolism, and various inner organs. Animal experiments show that at high noise intensities the noise effects can also attack the pituitary-adrenal cortex system.

Greenwood, Donald D. & Goldberg, Jay M. Response of neurons in the cochlear nuclei to variations in noise bandwidth and to tone-noise combinations. *Journal of the Acoustical Society of America*, 1970, 47(4, Pt. 2), 1022-1040.

Experiments were performed in which bands of noise were widened (arithmetically) around the best frequencies of single units in the cochlear nuclear complex of 12 cats. 2 types of effect were studied: (a) summation, in which increasing bandwidth from narrow widths (constant spectrum level) produced increases in firing; and (b) suppression, in which increasing bandwidth beyond the range in which summation occurred produced systematic reductions in firing. In monotic units, in which summation was more readily observed, increasing bandwidth was approximately equivalent to increasing the spectrum level of a narrow band of constant width; the subsequent suppression at larger bandwidths ranged from slight to very marked. The bandwidths at which summation ceased and suppression began, decreased somewhat at high spectrum levels and were similar in width on a log scale for units of differing best frequency but, for several reasons, these turnover bandwidths were not readily interpretable. Tone-noise combination stimuli were also used to study some units, and it was possible to repeat and extend earlier observations by D.D. Greenwood and N. Maruyama to the effect that depending on intensity a band of noise centered at one frequency may eliminate, i.e., mask, a unit's response to a tone at a different frequency either (a) by inhibiting that response, or (b) activating the unit itself so that the tone has no additional effect.

Hammond, G. R., MacAdam, D. W. & Ison, J. R. Effects of prestimulation on the electromyographic response associated with the acoustic startle reaction in rats. Physiology & Behavior,1972, 8(3), 535-537.

Five male albino rats were presented with high intensity acoustic stimuli, alone (control trials). Stabilimetric measures of the startle reflex as well as the amplitudes and latencies of EMG activity to the stimuli were recorded. Both sorts of prestimulation depressed the amplitude of subsequent effector activity to the startle stimulus as well as the stabilimetric measure, indicating that demonstrations of stabilimetric depression caused by prepulses do result from direct effector inhibition. The auditory but not the visual prepulse increased the latency of the subsequent startle reaction. The inhibitory effects were not determined by effector activity initiated by the prepulse, supporting central rather than peripheral mechanisms of reflex inhibition.

Hayes, H. W. & Venables, P. H. EEG measures of arousal during RFT performance in "noise". Perceptual & Motor Skills. 1970,31(2),594.

EEG alpha of 21 undergraduates was measured during upright Rod and Frame Test (RFT) performance in 6 blocks of 4 trials in a portable apparatus. Neither the stability of RFT performance nor the amount of EEG alpha was found to be affected by loud earphone noise delivered whenever alpha exceeded 80% of Ss maximum alpha. Results are discussed in relation to Oltman's proposal that RFT performance may be influenced by physiological arousal.

Horvath, T., Kirby, H. W. & Smith, A. A. Rats' heart rate and grooming activity in the open field. Journal of Comparative & Physiological Psychology, 1971, 76(3), 449-453.

Thirty male Long-Evans hooded rats were observed in a novel open-field situation under different levels of white noise and illumination. Grooming and heart rate were recorded, the latter with a telemetry apparatus. Heart rates were lower when white noise and illumination were present, but no differences between groups exposed to different intensities were found. No grooming differences, either in amount or distribution in time, were observed. It is concluded that heart rate and grooming in novel open-field situations are unrelated.

Hrubes, V. & Benes, V. * The influence of repeated noise stress on rats. *Army Foreign Science and Technology Center Charlottesville Va.*, 1971, Report No. FSTC-HT-23-246-71.

The effect of repeated noise on rats was investigated. An increased excretion of catecholamines in the urine, a rise in the level of free fatty acids in the blood plasma, an increase in the weight of the adrenals, and an inhibition of growth of the animals was determined, in comparison to untreated control animals and to the initial values of the test animals. The course of the weight curves showed characteristic changes also. Excretion of 5-hydroxyindoleacetic acid did not change significantly, however.

Hunter, Edna J. Autonomic responses to aircraft noise in dyslexic children. *Psychology in the Schools*, 1969, 6, 362-7.

The effects of noise from low-flying aircraft on autonomic response patterns were analyzed in dyslexic children (RDS) and a group of matched controls (CS) during a task and a no-task situation. Nonreaders and CS were compared for skin conductance level, skin potential response, heart rate level, heart rate response, finger pulse level, and finger pulse response. The RD child appeared more distracted by the noise and elicited significantly larger noise-evoked skin potential and heart rate responses than CS, but only when the noise occurred while task-oriented. Data support the hypothesis that defective inhibitory mechanisms, not defective arousal levels, underlie the attentional deficit of the nonreader.

Jackson, Donald E. Prolonged exposure to high-intensity noise: I. No effect on subsequent acquisition of conditioned suppression. *Proceedings of the Annual Convention of the American Psychological Association*, 1970, 5(Pt. 1), 27-28.

Observing reports that rats exposed to high-intensity sounds suffer physiological and metabolic changes, 24 *S*s were exposed to constant noise (102 dB.), intermittent noise, or control conditions 45 minutes daily for 25 consecutive days. Following 5 days rest and 9 days variable-interval training, *S*s received 2 days CER training. Following 2 recovery days, *S*s were given 9 days CER extinction. Analysis of suppression ratios indicated no significant treatment effect; nor were earlier findings of weight loss following noise exposure confirmed. Since data hinted that noise *S*s were less suppressed, there was agreement with others that prior stress may render subsequent stress less noxious.

Jansen, G.*Noise as a cause of disease. *Army Foreign Science and Technology Center Charlottesville Va.*, 1971, Report No. FSTC-HT-23-241-71.

Results of medical noise research presented here are sufficient grounds for physicians to promote effective and technical noise control, since human health is jeopardized by noise. Technical and acoustical experts often say that we can become accustomed to noise, and that noise control is not necessary to the extent that it is required. Medical research in recent years seems to have shown clearly that such habituation does not exist, at least in the autonomic sphere, even if noise is tolerated as a physiological phenomenon. Noise research has already provided evidence that the physicians' demands are justified.

Jatho, K. *Psychological and physiological-organic damage due to the effects of noise and high sound and tone intensities. *Army Foreign Science and Technology Center Charlottesville Va.*, Report No. FSTC-HT-23-252-71.

The article reports on the psychological and physiological-organic damage due to the effects of noise and high sound and tone intensities. The individual in modern industrial society is forcibly subjected to acoustically damaging factors in meeting places, down-town areas of large cities and in many places of work. The organism and sense of hearing react to these with first temporary and then lasting disturbances.

Keating, Lawrence W. & Ruhm, Howard B. Within average variable of the acoustically evoked rerponse. *Journal of Speech & Hearing Research*, 1971, 14(1), 179-188.

The effects of various tasks, designed to alter the degree of "attention to stimuli", on the variability of the EEG activity which gives rise to the average acoustically evoked response were explored. Evoked responses to 50- dB SL clicks were recorded from the vertex of 8 male graduate students under four conditions: quiet, counting, discriminating, and reading. Results show the quiet condition yielded the greatest variability while reading exhibited the least.

Keinosuke, Sakashita. *Effects of acoustic stimuli on guinea pigs. Experimental studies on the effects of long-term and repeated acoustic stimulation on the inner ear pituitary - adrenal cortex. *Army Foreign Science and Technology Center Charlottesville Va.*, Report No. FSTC-HT-23-253-71.

Guinea pigs were exposed for a long period to strong acoustic stimulation (4,000 cps, 100-115 dB). They were divided into the 10 day group (exposed to noise for three hours per day for 10 days), the 23 day group (12 hours per day for 23 days), and the 40 day group (12 hours per day for 40 days). In all groups morbid change of the inner ear, the biochemical function of the pituitary-adrenal cortex system, and the pathological-histological observations of these organs were compared. In connection with the so-called Selye's general adaptation syndrome, the pathological physiology of living bodies was pursued, and relationships with endocrinal metabolism in noisy workshops were compared and investigated.

Kharkevich, D. A. & Sinitsyn, L. N. The influence of sodium oxbutyrate on exitatory conduction in afferent systems when different sensory modalities are stimulated. *Farmakologiya i Toksikologiya*, 1969, 32(3), 265-270.

*S*s were cats subjected to urethane and chloralose narcosis. Evoked potentials were recorded in the cerebral cortex and in specific, associative, and nonspecific thalmic and mesencephalic structures, following supra- and submaximal electrical stimulation of the vagus, inferior cardiac, and sciatic nerves, and photo and audiostimulation. Sodium oxybutyrate inhibited evoked potentials following stimulation of the visceral nerves and increased potential amplitude, following stimulation of the sciatic nerve and after photo- and audiostimulation. It appears that sodium oxybutrute exerted primarily a blocking action on the conduction of excitation in the afferent pathways of the visceral nerves (inferior cardiac and vagus nerves).

Kohlenberg, Robert J. Instructions to ignore a stimulus and the GSR. *Psychonomic Science*, 1970, 19(4), 220-1.

Twelve undergraduates were presented with three different tones and instructed *S*s to ignore one of them. Results indicate that the GSR is enhanced for the ignored stimulus and support the notion that effects due to signal value are larger than the effects due to demand characteristics.

Landers, William F., Ball, Steven E. & Halcomb, Charles G. Digital skin temperature as a physiological correlate of attention in nonretarded and retarded children. *American Journal of Mental Deficiency*, 1972, 76(5), 550-554.

Digital skin temperature (SKT) of 20 9-yr-old nonretarded and mildly retarded Negro males was recorded during alternate periods of white noise and a movie to test that decreases in SKT reflect a physiological component of the attentional process, and that attentional differences of nonretarded and retarded *S*s are manifested in this hypothesized physiological correlate of attention. Results indicate that: (a) SKT decreases occurred to changes in environment for both nonretarded and retarded *S*s, (b) SKT drop durations were longer during the movie than during white noise for all *S*s, and (c) SKT changes did not conclusively differentiate between nonretarded and retarded *S*s.

Lown, Bernard, Verrier, Richard & Corbalan, Ramon. Psychologic stress and threshold for repetitive ventricular response. *Science*, 1973, 182, 834-836.

A psychologically stressful environment reduced the threshold of the dog's ventricle for repetitive response. Elicitation of such a response indicates the presence of electrical instability and a predisposition to ventricular fibrillation, the mechanism of sudden death.

Matsui, Kiyoo & Sakamoto, Hiroshi. *Studies on water content in the brain in a noisy environment. *Army Foreign Science and Technology Center Charlottesville Va.*, 1971, Report No. FSTC-17023012301.

The experiments were undertaken to clarify the revelation between the water metabolism and the noisy environment as compared with cold. 100 to 105 phon noise characterized by wide octave band spectrum at room temperature (20C) was used. The temperature in the cold condition was 10C. The adult male rabbits were arranged in 4 groups of 5 animals each; control, exposure to cold, one or repeated exposure to noise. The rabbits were exposed to cold for 90 minutes, and to noise for 3 hours once or 8 hours daily during one month. There-after, the brain was removed and separated into 7 parts; cerebrum, cerebellum, upper and lower part of mesencephalon, interbrain, medula oblongata, and pons. The water content was determined by Hatschek's method. Results were: (1) in the control group, the free water content in cerebrum and cerebellum were higher than that in medulla oblongata, pons and upper-part of mesencephalon. The bound water content in cerebrum and cerebellum were lower than that in medulla oblongata and upper-part of mesencephalon.

Maugeri, Salvatore & Odescalchi, Cajo P. Occupational Noise: Present day problems, pathology, and preventative measures. *Securitas*, 1968, 53(5-6).

The characteristics of noise (intensity, frequency, duration timbre, etc.) is described and draws a distinction between occupational and non-occupational noise. The effect of the noise is felt across the channels of the sympathetic system and centrally, on the diencephalic centers (reticular substance). Occupational noise harms the hearing organs of the worker in a characteristic and constant manner, and frequently is the cause of accidents as a result of interfering with verbal communications. It affects the performance of man-machine systems and disturbs the community at large. The prevention of the damage caused by noise must begin by acting on the source of the noise itself and on the work environment. A criteria for evaluating the risk, based on daily exposure to noise for a period of 290 working days is proposed. A review of technical and medical prevention, and occupational audiometry both at the time of starting work and periodically repeated is presented.

Mayer, J. *New data of acute acoustic trauma (auditory trauma due to sudden noise) based on new measurement techniques. Army Foreign Science and Technology Center Charlottesville Va.1971, FSTC-HT-23-249-71.

On the basis of a special measuring technique it was possible, in addition to level measurements, to show the distribution of sound energy for short sound impulses and to construct a frequency spectrum. The physical principles of acute acoustic trauma (trauma due to acoustic shock) were broadened.

Mefferd, Roy B.,Jr., Sadler, Timothy G., & Wieland, Bett A. Physiological responses to mild heteromodal sensory stimulation. Psychophysiology, 1969, 6(2), 186-96.

The interaction of 3 pairs of heteromodal sensory stimuli-reading vs. continuous banging noise, continuous flashing light vs. banging noise, single flash vs. bang was evaluated. Order of presentation was confounded both within and between Ss. Interstimulus time periods were 15 sec. with the last. Although most variables had large mean differences in the expected direction, the largest and most often significant effects were with GSR. The responses were less with a stimulus imposed either simultaneously or within a short period after another, than they were to the stimulus imposed alone. Habituation effects were marked.

Nash, Richard F., Gallup, Gordon G. & McClure, Michael K. The immobility reaction in leopard frogs (Rana pipiens) as a function of noise-induced fear. Psychonomic Science, 1970, 21(3), 155-156.

It was hypothesized that a loud preinduction noise should prolong the duration of the immobility reaction by increasing the level of fear or arousal prior to manual restraint. Thirty-four frogs served as Ss, with

1/2 receiving a loud noise just prior to being immobilized, while the remainder serves as a control group. *S*s exposed to preindiction noise remained immobile significantly longer than controls. Results are discussed as providing additional support for the idea that the immobility response represents an innate fear reaction.

Nielsen, D. W., Teas, D. C. & Idzikowski, R.P. Variation in cortical evoked responses as a function of performance criterion. *Perception & Psychophysics*, 1970, 8(1), 29-32.

Averaged evoked cortical responses (CER) were recorded from the scalp of human *S*s within an experimental paradigm that permitted the performance criterion to be varied. The signals evoking the cortical responses were contingent upon *S*'s pressing a button to bisect a temporal interval within certain tolerance limits. Under passive conditions averaged response waveforms lacked a 2nd, late component that became prominent under temporal bisection conditions. The late component P2-N2, was neither as large nor as systematic as that shown by P2-N2.

Osterhammel, P., Terkildsen, K. & Arndal, P. Evoked responses to SISI stimuli: Contralateral masking effects. *Acta-Oto-Laryngologica*, 1969, 263, 245-247.

In an experiment with 3 *S*s, it was found that evoked cortical responses to Short Increment Sensitivity Index type stimuli at 20-dB sensation level and increment magnitudes 2,3, and 5 dB. tended to be enhanced by the application of contralateral masking noise. With 5-dB increments and the continuous tone at the threshold of hearing, the same masking noise caused the response to disappear. The enhancement of auditory discrimination at suprathreshold levels through application of contralateral masking and the central masking effect at the threshold are thought to be comparable to the so-called indirect adaptation mechanism of the eye, and an indication that the efferent innervation to the cochlea is important for the adaptation of the ear.

Pfefferbaum, Adolf, Buchsbaum, Monte & Gips, James. Enhancement of the average evoked response to tone onset and cessation. *Psychophysiology*, 1971, 8(3), 332-339.

Auditory average evoked responses (AERS) produced by tone onset (on responses) and tone cessation (off responses) were studied in 14 normal 19-26 yr. old adult *S*s. When short (500 msec.) tone bursts were presented widely spaced (2500 msec. between tones), on responses were large, in contrast to off responses, which were less than 1/3 their size. But when long tones (2500 msec.) were succeeded by brief (500 msec.) silences, off and on responses were comperable in size. In addition to this observed effect of the ratio of the % of time the tone was on to the percent of time the tone was off, control experiments suggest that increased duration of preceding interval, enexpectancy of stimulus occurrence of stimulus, and decreased mean frequency of stimulus presentation all increase the amplitude of both off and on responses. Off responses were found to be more sensitive to stimulus spacing effects than on responses.

Pollak, George David. An investigation of masking the cochlear nucleus of the cat. (Doctoral dissertation, University of Maryland) Ann Arbor, Mich.: University Microfilms, 1970, No. 71-4052, 162 pages.

The behavior of slow waves from the cochlear nucleus in response to tone bursts and tone bursts in narrow and broad band noise was investigated. Three different groups of experiments were performed. In the Group I experiments the origin of the slow wave activity was identified. This was accomplished by topically applying tetrudotoxin (TTX) to the cochlear while slow waves and cochlear microphonic responses were recorded. It was found that the TTX completely abolished the slow wave while leaving the microphone response unaffected. It was therefore, concluded that the slow waves did not originate from hair cells potentials but were, in fact, neural in origin. The Group II experiments demonstrated that the slow wave responses from the PVCN can be elicited in a tonotopic fashion. This tonotopic organization was in agreement with single unit studies performed in the subnucleus. The Group III experiments were concerned with the manner in which the slow waves were masked by narrow and wide band amplitude modulated noise. The results of the narrow band noise experiments may be summarized as follows: 1) Only a limited band of frequencies are effective in masking the response to a tone burst. This band of frequencies is called the masking bandwidth (MBW); 2) the size of the MBW increases linearly with tonal frequency; 3) the size of the MBW increases as the relative intensity is raised.

It was expected that if wide band noise were to mask a tone whose MBW was found to be considerably narrower than the noise bandwidth, this noise would be less effective in masking the tone than narrow band noise of equal power because some of the energy in the wide band noise was spread to frequencies which were outside of the MBW and thus considered to be ineffective in the masking of this particular tone. This expectation was not realized. The data shows that noise whose bandwidth significantly exceeds the MBW does not produce less masking than noise of equal power whose spectral components are entirely within the limits of the MBW.

The results are discussed in the light of psychophysical experiments and in terms of the current knowledge of the behavior of single units in the auditory system.

Rasbury, W. & Shemberg, K. The effects of aversive levels of white noise. *Psychonomic Science*, 1971, 22(3), 166-167.

This research investigated the effects of aversive levels of white noise on consummatory behavior with 15 male Holtzman rats assigned to each of three conditions of sound level (90,100, and 110 dB) and 15 to a no-sound control group. Results show that *S*s in the sound treatment conditions consumed significantly greater quantities of food on the second sound treatment day than controls. In addition, there were no systematic differences in consummatory behavior among the three treatment conditions.

Raskin, David C., Kotses, & Baver, James. Cepnalic vasomotor and heart rate measures of orienting and defensive reflexes. Psychophysiology, 1969, 6(2), 149-59.

The problem of differentiating orienting (OR) and defensive reflexes (DR) was studied by measurement of forehead-skin pulse amplitude (PA) forehead skin blood content (BC), and heart rate (HR). Thirty male undergraduates received thirty stimulations of .5-sec. white noise at either 80 or 120 dB. Analyses of the physiological measures indicated that both intensities of stimulation produced decreases in PA. Forehead BC showed larger increases to 120 dB than at 80 dB., and successive stimulations produced a change to overall decreases in BC at both intensities. HR acceleration occurred to both stimuli, and a short latency deceleration occurred to 80 dB. Results showed that cephalic vasoconstriction is the dominant response to auditory stimulation and that cephalic vasomotor responses do not differentiate between ORs and DRs. The short latency HR deceleration and smaller HR acceleration differentiated the OR from the DR.

Rothschild, Henri C. The effect of high intensity noise of varying frequencies on neuroendocrine response in the rat. Dissertation Abstracts International, 1973, 33(9-B), 4326.

High intensity ambient noise is becoming increasingly evident as an environmental pollutant. One biological effect of high intensity noise is the production of a condition of physiological stress. The capacity of noise to generate a stress response in an organism allows the evaluation of the potentially deleterious effects of high intensity noise by the measurement of physiological variables such as the excretion of potassium and sodium in the urine. In the present investigation, urinary K/Na ratios were studied to determine whether the stress response of the organism to high intensity noise varies with the frequency of the sound.

Twelve studies were undertaken: six studies at 65 db and six studies at 120 db. In each study, six experimental and six control animals were used. The noise treated animals were subjected to a 30 minute exposure of sound. Pure tone frequencies of 1000, 2000, 4000, 8000, and 10,000 Hz were used, as well as a broad-band frequency at 1000-10,000 Hz. Urine was collected prior to the noise exposure, or control conditions from all animals as well as at intervals of 6, 12, and 18 hours following noise exposure. Blood was collected from the animals at the 18 hour sampling period and analyzed for glucose content. Urinary K/Na ratios were determined by flame photometry and blood glucose content was determined by an automic analysis based on the enzymatic degradation of glucose.

No effective difference in urinary K/Na ratios was observed between treated and control animals at any of the frequencies studied for 65 dB. Analysis of the data obtained for the 120 dB study showed, in all frequencies except 2000 Hz, a drop in the urinary K/Na ratio of the noise treated rats relative to controls 6 hours after noise exposure. In the study undertaken at 120 dB and 10,000 Hz, the urinary K/Na ratio for the noise-treated rats decreased 48.78% after 6 hours relative to the corresponding controls. This was the greatest drop in urinary K/Na ratios scored at 6 hours. The percent decrease of urinary K/Na ratios for the other studies at 120 dB, 6 hours after the noise were 35.25%, 29.95%, 43.00%, and 30.85% for the studies at 1000, 4000, 8000, and 1-10,000 Hz respectively. The general pattern of response in all studies at 120 dB was a return to control urinary K/Na values at 12 and 18 hours following noise. In the 8000 Hz study, the urinary K/Na ratio of the noise treated rats at 12 hours was lower than the corresponding control by 56.05%. The decrease in urinary in urinary K/Na ratios in the noise treated animals 6 hours following the noise was greatest at 10,000 Hz, although, no statistically significant variation of the response at 6 hours with the frequency of the sound was found. The results of the investigation nevertheless can be interpreted to shwo that, at the higher frequencies studied, the stress response was more pronounced. The study undertaken at 120 dB and 2000 Hz showed no difference in urinary K/Na ratios of noise treated and control rats. The data suggest that, at 2000 Hz, white rats may exhibit some degree of resistance to noise stress. There was no significant change of blood glucose levels in the noise treated rats relative to controls in any of the studies taken.

Segal, Richard F. & Isaac, Walter. Sensory influences upon amphetamine tolerance. *Physiology & Behavior*, 1971, 7(6), 877-879.

The effects of illumination, noise, and d-amphetamine upon locomotor activity in 12 Cherukee SD male albino white rats was studied. While both noise and illumination altered activity level, only illumination was related to drug effects. The effectiveness of the drug was found to decrease, primarily in the dark, over repeated trials.

Semczuk, Boleslaw. *Investigation of the effects of acoustic stimuli on respiratory movements. *Army Foreign Science and Technology Center Charlottesville Va.*, 1971, Report No. FSTC-HT-23-274-71.

Respiratory movements of the chest were recorded in 150 healthy subjects (100 adults and 50 children) by means of a thoracograph and kymograph, while pure tones of a definite frequency and intensity, generated by an audiometer, were delivered to both ears. The tests were done in the waking state amd om physiological sleep. The results have shown that supraliminal acoustic stimuli markedely change the respiratory movements and that, contrary to other stimuli (visual, for example), they elicit no adaptation of the body to repetitive acoustic stimulation. Changes produced in respiratory movements by acoustic stimuli are discussed in detail.

Stern, Robert M., Gaupp, Larry and Leonard, William C. A comparison of GSR and subjective adaptation to stressful stimuli. *Psychophysiology*, 1970, 7(1), 3-9.

Subjective and physiological adaptation, as measured by magnitude of GSRs, to electric shock and auditory noise were compared. In Exp.1, 48 undergraduates received 15 shocks of constant intensity, one subgroup always receiving low shocks and the other high. *S*s were told that shock intensity would vary and rated the intensity of each shock immediately following its presentation. In Exp. II, the same procedure was followed with 50 different *S*s, using noises instead of shocks. Shock *S*s showed subjective adaptation but no GSR adaptation. Noise *S*s showed GSR adaptation with an increase in subjective intensity reports. The importance of anticipation, in terms of level of arousal at the onset of the session, is discussed.

Strakhov, A.B. On the dynamics of critical electrical responses to photic stimulation under the action of intense noise in man. Zhural Vysshei Nervnoi Deyatel Nosti, 1968,18(5),873-9.

Twenty humans were used to study the influence of high-frequency noise (95-100 dB) up to one hour) on cortical responses invoked by rhythmic photostimulation (9 cps.). Five of the original Ss were used in a similar study, and, after prior administration of M-cholinolytics (scopolamine, aerone), recordings were made every 3-5 minutes of the EEG and responses to light flashes. The action of the applied noise was accompanied by a growing generalized depression of alpha-rhythm which developed for the duration of "several tens of minutes". Photo-stimulation, applied at the onset of noise, led to the emergence of bursts of alpha-rhythm which weakened and completely disappeared with continuation of its action. Cessation of exposure to noise at first led to the appearance of bursts of alpha-rhythm in response to photo-stimulation and later to its full restoration. The application of M-cholinolytics retarded the development of these changes in the CNS. These data are interpreted as the result of: (a) the development of an inhibitory state in the cerebral cortex owing to the activation, under the action of noise, of the reticular structures of the inferior sections of the brainstem; and (b) the release of inhibitory mechanisms located in the nonspecific thalmus. The loss of cerebral capacity to react to afferent impulsation under the action of intense noise lies at the basis of many changes in the activity of the CNS individuals subjected to the chronic action of noise.

Thalken, Charles E. Use of beagle dogs in high intensity noise studies. School of Aerospace Medicine Brooks AFB Tex., 1971, Report No. SAM-TR-70-423.

To evaluate the effects of high intensity white noise, beagles were individually exposed to noise levels of 120 decibels. The stressing effects of noise at this intensity were studied by determining changes in circulating venous levels of 17-hydroxycorticosteoid (17-OHCS, cortisol).

Steroid levels in blood samples were analyzed using the Peterson modification of the Porter-Silber colorimetric reaction. No significant differences ($P<0.05$) in circulating steroid levels could be detected between control samples and samples taken after noise exposure. This study suggests that high intensity white noise does not detectably stress dogs as it does other animals. Therefore, the canine may not be the animal of choice for investigations utilizing noise in the range most important mentally and physically to man.

Udalov, Yu. F., Lapaev, E. V. and Syzrantsev, Yu. K. Effect of aviation noise on some indices of protein and vitamin metabolism. *Army Foreign Science and Technology Center Charlottesville Va.*, 1971, Report No. FSTC-HT-23-272-71.

Research results in this report point to the need for wider employment of vitamins and glutamic acid to prevent the damaging effects of noise on flying personnel and aircraft maintenance personnel.

Welch, Bruce L. & Welch, Annemarie S. (Eds.) Physiological effects of noise. New York, N.Y. *Plenum Press*, 1970.

Papers presented in this volume represent the content of a 1969 symposium devoted to the physiological effects of audible sound. Contributions represent the efforts of scientists from the western hemisphere and both eastern and western Europe. Papers are presented based on both human and infra-human data in the areas of: Adaptation, Disease resistance; Endocrine and metabolic function; Cardiovascular and reproductive effects; Neurological, biochemical and pharmacological effects; Sleep and sonic boom studies.

Williams, D.I., Wells, P.A. & Lowe, G., Light reinforcement, noise and arousal level. *Nature, New Biology*, 1971, 232(29), 95-96.

Using 80 male hooded rats results of an experiment with continuous auditory stimulation in light reinforcement situation support the prediction from arousal theory. Responding for light was depressed in the noise condition whereas there was no difference in responding in the control groups.

Williston, John S. Habituation of the multiple unit discharge response to white noise stimulation in the unanesthetized rabbit. (Doctoral dissertation, University of Southern California) Ann Arbor, Mich:, University Microfilms, 1969, No. 70-5233.

Certain characteristic parameters have been found in studies of the habituatioon of responses as diverse as monosynaptic spinal reflexes and exploratory behavior. Previous work with the EEG arousal response indicate that certain neural activity may also conform to these parameters, although the exact meaning of the EEG changes in habituation training with the less ambiguous multiple unit response in a variety of subcortical areas.

Fifteen rabbits were chronically implanted with asymmetrical bipolar electrodes stereotaxically directed to a number of sites in the brain, particularly the mesencephalic reticular formation, brachium of the inferior colliculus, and medial geniculate. Following surgery and a recovery period, the animals were restrained inside a sound-attenuated box for three sessions of adaptation to the experimental environment and then given six additional days of habituation training to white noise.

The animals were randomly assigned to either a ten- or thirty-second intertrial interval group and also to a sequence of the three intensity levels of white noise stimulation of 60, 80, and 100 db. Two days of habituation at each of three noise intensity levels were given at the assigned intertrial interval with a day of rest between different intensity conditions. Each day's session consisted of 56 presentations of a two-second burst of white noise and a two-second dishabituatory bright-light stimulus immediately preceding the noise onset on the 16th, 24th, 32nd, 40th, and 48th trials. The major response reported was defined as the net change in unit activity between a two-second control period preceding noise onset and the two two-second period during the stimulus presentation.

In general, substantial decrements in the multiple unit response to the novel white noise stimulus developed in auditory, nonspecific, association, and extrapyramidal sites. These changes were quite significant in the brachium of the inferior colliculus ($p < .005$), medial geniculate ($p < .01$), and reticular formation ($p < .025$). On the second day of stimulation decrements occurred faster and more profoundly, indicating that the effects of training persisted overnight. Some spontaneous recovery did occur, but the response did not appear to return to prestimulus levels. Other parameters were examined in the auditory and reticular formation placements. A shorter intertrial condition led to faster and more profound habituation, as did weaker stimulus intensities. Both effects were statistically significant in all three structures. Dishabituation was seen in the two auditory structures but was more ambiguous in the reticular formation. Here, an interaction with the excitation evoked by the light stimulus led questions regarding possible occlusional mechanisms. When dishabituation trials were repeatedly presented, this arousal response diminished in intensity in all structures observed.

These results support the view that a net decrease in the firing of neurons in a number of neural areas parallels the loss of the arousal or EEG desynchronization response in the central nervous system and a variety of peripheral responses. The development of this stimulus-specific decrement may reflect the loss of an excitability necessary for evocation of these responses. The variability observed between structures does not support the view that the decrement which appears at early synaptic relays is due mainly to inhibition exerted there from higher structures but does suggest that these results are due to the existence of an inhibitory mechanism operating at all levels of stimulus input and processing.

SLEEP

For the most part, these studies deal with the disruptive effects of noise on sleep. The research includes investigations of both intermittent and continuous noise.

Several investigators have been concerned with aircraft noise and sonic booms. In general, no major disruptions of sleep patterns are reported for Ss experiencing sonic booms. Where effects are reported, they are minor and are all correlated with the booms. Age and sex differences are observed in several reports. Some studies, concerned with performance decrements on the day following administration of simulated sonic booms, revealed no significant effects.

Studies using intermittent noise "pings" showed no significant effects on sleep patterns. Once again, as with sonic booms, the normal sleep patterns seemed to correlate with the onset of the stimulus. Some subjective complaints of difficulty in falling to sleep were not corroborated by observable data.

Other studies using white noise revealed some changes in EEG sleep patterns. Stage REM sleep was disturbed. Scott (1972) reported compensatory increases in REM sleep on quiet nights following noisy nights. Age effects and impairment on cognitive tasks are observed for both continuous and impulse noise conditions.

Brezinova, V., et al. The Czechoslovak EEG Commission: Subjective appraisal and EEG of night sleep disturbed by sounds in normals. *Electroencephalography & Clinical Neurophysiology*, 1967, 22(3), 285-286.

Noise and verbal stimuli, applied during the greater part of the night sleep of 20 normal *Ss*, reduced the amount of high voltage slow waves and disturbed the development of the normal sleep cycles. *Ss* evaluating their sleep as poor did not differ from Ss with subjectively good sleep in the EEG quantities of alertness, sleep and in numbers of EEG arousals; they showed a more frequent incidence of subjective awakening, a greater score in the MA scale. Ss who felt drowsy in the morning showed a smaller number of EEG arousals and better preserved high voltage slow wave periods during the night, a more frequent incidence of very good sleep in the last six months.

Chiles, W.D. & West, Georgetta. Residual performance effects of simulated sonic booms introduced during sleep. *FAA Office of Aviation Medicine Report*, 1972, 72-19, 8 p.

Eight Ss each in three age groups (21-26, 40-45, 60-72 yr. old) were tested with the Multiple Task Performance Battery for 30 minutes every morning and evening for 21 consecutive days. Tasks involved mental arithmetic, pattern discrimination, monitoring meters and monitoring warning lights. All Ss slept in the laboratory during baseline (days 1-5), boom (days 6-17) and recovery (days 18-21) phases of a study of the effects of simulated sonic booms. During the 12 boom nights, there were hourly presentations of simulated sonic booms of 1 pound/sq.ft. (outdoor measure). Significant age effects and time-of-day effects emerged for five of the 10 performance measures, but there were no measureable consequences on performance which could be attributed to the booms.

Collins, William E., & Iampietro, P.F. Simulated sonic booms and sleep: Effects of repeated booms of 1.0 psf. *FAA Office of Aviation Medicine Report*, 1972, 72-35.

Eight male Ss in each of 3 age groups (21-26, 40-45, and 60-72 yr. old) slept in pairs in a sonic boom simulator facility for 21 consecutive nights. The first 5 nights acclimated the Ss (nights 1 and 2) and provided baseline data (nights 3-5); the 12 subsequent nights (boom) involved the hourly presentation of simulated sonic booms at an outdoor overpressure level of 1 lb./sq.ft.; during 4 additional nights (recovery) there were no boom presentations. All night records of EEG, electrooculogram, EMG, electrocorticograms, and basal skin resistance (BSR) were obtained and analyzed. None of the physiological measures showed statistically significant effect of the boom presentation on nightly sleep patterns. However, average heart rate increased during the minute following each boom (by less than 1 beat/min), EMG responses occurred for 45-50% of the booms, and BSR changed following 19% of boom presentations. The frequency of these occurrances increased as a function of age. That these changes were probably mild is supported by the facts that only 5% of the booms produced awakening and only 14% produced shifts in stages of sleep (4% of the stage shifts might be expected by chance); both of these measures showed higher frequencies of occurrence as a function of age.

Johnson, Laverne C., Townsend, Richard E., Naitoh, Paul, & Muzet, Alain. Prolonged exposure to noise as a sleep problem. *Navy Medical Neuropsychiatric Research Unit San Diego Calif.*, 1973, Report No. NMNRU-73-33.

In one 15-day and one 55-day laboratory study and one operational 7-day training cruise, the effect of 24-hour-a-day exposure to pings of intensities ranging from 80-90 dB SPL on sleep was examined. Pings were less than a second in duration with an interstimulus interval of 45 or 22 seconds, and in the 3-4 KHZ frequency range. Maximum duration of ping exposure was 30 days. In this young adult sample, exposure to the noise did not produce a decrease in sleep duration or an increase in number of awakenings. There were, however, reports of sleep onset difficulty and a decrease in percent of sleep stage four during ping exposure. No significant changes in waking performance or behavior were found as a result of the ping exposure during any of the three studies.

Kramer, Milton; Roth, Thomas; Trindar, John, & Cohen, Alexander. *Cincinnati University of Ohio College of Medicine*, 1971, Final Report, 174 p.

The study investigated the effects of noise on sleep and post-sleep behavior in two 25, 60, and 70 year-old males. The subjects were run for 15 consecutive nights, the first five and the fifteenth serving as controls. Following each night's sleep, subjects completed a series of performance and psychological tests. Threshold sound levels for sleep disturbance were obtained for an impulse and a continuous test noise and discussed in terms of type of sleep disturbance stage of sleep, time of night, adaptation and age of subjects. The sleep profile results indicated that the pattern of noise-induced sleep disruption was related to age. The 25-year olds showed an increase in stage 1 and movement time. The 70-year olds showed an increase in time awake and a decrease in time spent in stage 3-4. The 50-year old subjects were intermediate with respect to each measure. The daytime performance data revealed no effects of noise-induced sleep disruption on pursuit rotor and reaction time tasks but some decrements were found in time estimation, arithmetic, and memory task measures. In addition, verbal sample scores demonstrated an increase in cognitive impairment and a decrease in human relations.

Lukas, Jerome S. & Dobbs, Mary E., Effects of aircraft noises on the sleep of women. *National Aeronautics and Space Administration*, 1972, CR-2041, 38.

The EEG and behavioral responses during sleep of eight 29-49 year old females exposed to subsonic jet flyover noise and simulated sonic booms on 14 consecutive nights was tested. Stimulus intensities were 101, 103, and 119 Pndb for the subsonic jet fly over and .67, 2.50 and 5.0 psf for the simulated sonic booms. *S*s were awakened, on the average, by approximately 42% of the flyover noises and by approximately 15% of the simulated sonic booms. Comparison with a previous study using males as *S*s reveals that females were awakened more frequently by the subsonic jet flyover noise, while males were awakened more frequently by the simulated sonic boom.

Mabry, J.E. & Parry, H.J. The effect of simulated sonic boom rise time and overpressure on electroencephalographic waveforms and disturbance judgements. *Man-Acoustics and Noise Inc Seattle Wash.*, 1973, Final Report, 19 p.

The three main objectives of this study were: determine the feasibility of investigating effect of simulated sonic booms on some sleep patterns of persons undergoing routine electroencephalographic (EEG) examinations; determine the extent that EEG waveforms are altered by the simulated sonic booms; and obtain "disturbance", judgements as a function of the simulated boom noises. Results were obtained from fifty (50) subjects of both sexes with ages ranging from 15 to 72 years of age. Data were relevant to resting, dozing, or light sleep. The EEG waveforms for resting or dozing persons was not changed by the simulated boom noises. In general, the subjects were not, "disturbed" by the simulated booms. Ninety-two (92) percent of the subjects reported no, "disturbance" to any of the simulated booms presented. Two rise times of 15 and 7 ms were employed with overpressures ranging from 0.94 to 2.85 PSF.

Minard, J., Quick, G., Gory, Eliot, & McWilliams, Jun-Ko. Polygraphically recorded rapid eye movement and reliably observable behavior obtained during sleep as indicators of neonate function: Effects of major tranquilizers and nursery noise. *Proceedings of the Annual Convention of the American Psychological Association*, 1971, 6, 185-6.

This report describes exceptions to previously reported patterning and day to day change in cumulative REM records of sleeping neonates. An infant lacking patterning had REM abolished by nursery noise and proved hyperactive. Marked day to day REM increas and absence of sleep onset REM were observed in neonates of mothers given major tranquilizers during pregnancy. Related studies suggest nursery noise usually lacks marked effect of REM measures, absence of sleep-onset REM is unusual and latency from lid closure to directly observed REM has convenience, reliability and stability in neonate research.

Olivier-Martin, N.; Schrieber, J.P., & Muzet, A. Responses to questionnaires on nightime and daytime sleep while experiencing sleep disturbances through four levels of airplane noise. *Bulletin de Psychologie*, 1974, 26 (17-18), 972-994.

Intermediate and consecutive effects of sleep disturbance through four levels of airplane noise were compared. Nineteen 24 year old volunteer students served as *S*s. Audiogram recordings of *S*s responses were made at scheduled intervals during 4 days and 3 nights. *S*s completed questionnaires on night and daytime sleep, reporting on quality and quantity of various aspects. Data analysis was designed to relate physiological and personality characteristics of *S*s to responses on questionnaires. Preliminary analysis indicated immediate subjective effects manifested in reported difficulty in getting to sleep, diminution in quality of sleep, and altercation in patterns of waking. Female *S*s reported secondary effects. Differences were found between male and female *S*s in the subjective assessment and actual state of sleep.

Scott, Thomas D., The effect of continuous, high intensity, white noise on the human sleep cycle. *Psychophysiology*, 1972, 9(2), 227-232

Eight male undergraduates slept for eight consecutive nights under conditions of 91-95 db. white noise (N) and under normal quiet conditions (Q). On N nights the percentage of total sleep time spent in Stage REM was decreased (p .001), percentages of stages 1 and 2 were increased (p .05, p .001 respectively), and REM latency was increased (p .02) compared to Q nights prior to N nights). On Q nights following N nights, percentages of stage REM increased above baseline levels indicating compensatory recovery effects from REM sleep deprivation on prior N nights. Stages 3 and 4 remained unchanged throughout the study. Reduction in Stage REM on N nights was directly attributed to the effects of noise on the CNS and not a secondary result of increased number of awakenings on N nights.

Smith, R.C. & Hutto, G.L. Sonic booms and sleep: Affect change as a function of age. *FAA Office of Aviation Medicine Report*, 1972, 72-24.

The Composite Mood Adjective Check List was administered every morning and evening for 21 consecutive days to 8 *S*s in 3 age groups: 21-26, 40-45, and 60-72 year olds. All *S*s slept in the laboratory in baseline (days 1-9), boom (days 6-17), and recovery (days 19-21) phases of a study of the effects of simulated sonic booms. During the 12 boom nights, simulated sonic booms of 1 pound/sq ft (outdoor measure) were presented hourly. Although some clear differences were obtained related to age, no change in mood scores was attributable to booms.

Townsend, Richard E; Johnson, Laverne C., & Muzet, Alain. Effects of long term exposure to tone pulse noise on human sleep. *Psychophysiology*, 1973, 10(4), 369-376.

Electrophysiological and self-report data, were obtained from 10 and 20

U.S. navy enlisted men, respectively, during 15 days of baseline, 30 days of 24-hr per day exposure to a 660 msec, 3.5 k Hz tone pulse with a 22 sec interstimulus interval (10 days each at 80, 85 and 90 db), and during a 10 day postexposure period. A self-reported increase in difficulty falling asleep was not substantiated by objective sleep latency measures. Changes in total hours of sleep, number of awakenings, and percent time for sleep stages were of small magnitude and not consistently related to stimulus intensity. All 10 monitored Ss gave clear EEG and autonomic responses to the stimulus, with no evidence of response extinction over the 30 day exposure period. There was no change in the average all night heart rate. Total number of body movements during the nights did not change. However, the movements that did occur tended to be triggered by the stimulus, with most movements closely following the tone pulse. The youth and good health of the Ss, and the 24 hr. per day exposure, favoring rapid adaptation to the stimulus, are suggested to account for the lack of disruption of sleep.

SPEECH AND SPEECH INTELLIGIBILITY

Recent work in this area can generally be categorized as demonstrating the effects of noise on: The fluency of normal speakers; the restorative effects of those suffering disorders of speech and the intelligibility of speech and speech sounds. Silverman (1972) found fluency to increase as a result of masking noise whereas Gammon, Smith, Daniloff, Raymond and Chin (1971) had previously shown that noise masking produced a decline in speech quality and a disruption of rhythm. Misarticulation of consonants was most pronounced. Similar to Gammon et al (1971), Smith (1969) had previously shown that random bursts of 95 dB white noise increased disfluency.

The effects of noise on stuttering inhibition has been investigated by Barr and Carmel on two occassions (1969, 1971). In their earlier study, stutterers showed a decrease in the number and duration of stuttering blocks under two different high frequency, narrow band masking noise conditions. In their later study, again under high frequency narrow band masking, whenever rhythmic distress was observed, the subject was supplied the correct items in his non-masked ear. Immediate release of all stuttering blocks was observed. In contrast to the therapeutic results of noise with stutterers, Wertz and Porch (1970) failed to find significant differences in accuracy or quality of verbal performance of adult aphasis in the presence of continuous noise. Apraxic subjects' phonemic accuracy has also been shown to be independent of the influence of noise (Deal and Darley, 1972) Speech discrimination and speech intelligibility have been extensively studied. Kreul, Bell and Nixon (1969) have shown that noise level is an important factor in the difficulty of speech discrimination tests. Kreul (1971) also found that intervening noise increased the difficulty in speech discrimination for both words and nonsense syllables.

Barr, David F. & Carmel, Norman R. Stuttering inhibition with high frequency narrow band masking noise. Journal of Auditory Research, 1969, 9(1), 40-44.

Two ways of masking the speech of 10 stuterers were used. Patients were normal by conventional pure-tone and speech audiometry. The number and duration of stuttering blocks were compared under 3 test conditions: (a) while reading a prose passage with no masking noise present; (b) while reading in the presence of high frequency narrow-band masking noise at that frequency and in that ear which the greatest amount of auditory adaptation was shown on the Carhart tone decay test (adaptation of up to 35 dB. was found); and (c) reading in the presence of high frequency narrow-band masking noise at one "other" high frequency (4 or 6 kcps). Masking stimuli were always presented monaurally at the patient's 50-db sensation level. Normal controls with no decay showed no effects. In contrast, the stutterers showed a decrease in the number and duration of stuttering blocks under the 2 noise conditions, particularly at the frequency where the greatest amount of adaptation occurred. Two tentative hypotheses are presented to explain how high fraquency narrow-band masking noise may inhibit stuttering.

Barr, David F. & Carmel, Norman R. Stuttering inhibition with live voice interventions and masking noise. Journal of Auditory Research, 1970, 10(1), 59-61.

Five stutterers read a prose passage aloud while high-frequency narrow band noise was presented at that frequency range and to that ear showing the most auditory adaptation. Whenever rhythmic distress was observed, E supplied the correct items to the stutterer's nonmasked ear at 30 dB. re speech reception threshold. Immediate release of all stuttering blocks occurred with the live voice interventions, often with only the first sound of the blocked word being spoken by the E. By employing the procedure outlined, an additional therapeutic method is advanced for the treatment of stuttering. Implications are discussed in the light of research on dichotic listening tasks.

Brookshire, Robert H. Effects of random and response contingent noise upon disfluencies of normal speakers. *Journal of Speech & Hearing Research*, 1969, 12(1), 126-134.

Twenty normal speakers read a passage during a 30-min session divided into base rate (5 min.) conditioning (15 min.) and extinction (10 min.). Each read in random condition and contingent condition. During conditioning in random condition, Ss received .75-sec, 95-db bursts of white noise according to a random schedule. During conditioning in contingent condition, Ss received a burst of 95-db white noise each time they were disfluent. Ten Ss (Group RC) read in random condition on one day and in contingent condition on a subsequent day. The other 10 Ss (Group CR) read in the opposite order of conditions on the 2 days. Results indicate that the effects of random and contingent noise are influenced by the order of conditions. Random aversive stimuli caused increases in disfluency for Ss in both groups. Response contingent aversive stimuli caused a decrement in disfluency for Ss in Group CR, but not for Ss in Group RC. Analysis of poststimulus disfluency indicate that random aversive stimuli caused disorganization of the speech of Ss in Group RC.

Deal, Jon L., & Parley, Frederic. The influence of linguistic and situational variables on phonemic accuracy in apraxia of speech. *Journal of Speech and Hearing Research*, 1972, 15(3), 639-653.

Twelve apraxic Ss with minimal apharic involvement were tested in 4 experimental conditions: effects of instructions, effect of 3 different experimentally imposed response-delay intervals on a word-repetition task, effect of noise, and the effect of visual monitoring. Also studied in one or more of these conditions were the loci of errors in oral reading. Ss ability to predict and to recognize their errors, and the nature of errors made. Instructions, response-delay intervals, noise, and visual monitoring had no significant influence on phonemic accuracy. Ss had significantly more difficulty with 3-than with 1- syllable words. They made more errors in words weighted high than in words weighted low; word length and grammatical class appeared to be important characteristics influencing increases in errors. The ability of apraxic Ss to predict errors appears to be an individual characteristic. *S*s constantly made substitution, repetition, addition and omission errors. Results support the contention that apraxia of speech is a motor programming disorder.

Erber, Norman P. Auditory and audiovisual reception of words in low-frequency noise by children with normal hearing and by children with impaired hearing. *Journal of Speech & Hearing Research*, 1971, 14(3), 496-512.

Common words (monosyllables, trochees, spondees) were presented in low-frequency noise to 9 9-12 yr. olds who attempted to detect their acoustic patterns or to recognize them under a range of acoustic speech-to-noise (S/N) ratios. Both profoundly deaf (-10 db.) and severely hearing-impaired *S*s (-17 db.) required higher S/N ratios for auditory detection of words than did *S*s with normal hearing (-23 db.). The normals (92%) were superior to the severely hearing-impaired *S*s (57%) in auditory recognition of words in noise, while deaf *S*s (3%) were unable to recognize words by ear alone. The deaf *S*s were poor even at classifying the stimulus words by stress pattern. Provision of acoustic cues increased the audiovisual (AV) scores of normal-hearing and severely hearing-impaired *S*s 54% and 33%, respectively, above lipreading alone, but it improved the lipreading performance of profoundly deaf *S*s only 9%. Improvement in AV recognition depended for all groups upon their detection of acoustic cues for speech. The profoundly deaf *S*s achieved their maximum AV scores only at a higher S/N ratio (+5 db.) than that for the severely hearing-impaired *S*s (0 db.), who in turn required a higher S/N ratio for maximum AV recognition than did the normals (-10 db.).

Freedman, Sanford J. & Gerstman, Hubert L. The role of the pinna in speech intelligibility. *Journal of Communication Disorders*, 1972, 5(3), 286-292.

Nine normal-hearing adults listening through earphones were required to identify spoken words in a noisy background. Acoustic stimulation was picked up alternately by bare microphones and by microphones equipped with casts of human external ears (pinnae). Test scores and subjective impressions both indicated a highly significant and consistent superiority for the pinna condition.

Gammon, Sylvia A.; Smith, Philip J.; Daniloff, Raymond G. Kim, Chin W. Articulation and stress/juncture production under oral anesthetization and masking. Journal of Speech & Hearing,19.1, 14(2), 271-282.

Eight undergraduates, 1/2 of them naive and the other 1/2 aware of the purpose of the experiment, spoke 30 pairs of sentences involving the production of intricate stress/juncture patterns along with a passage containing all major consonant phonemes in English in various intra-word positions. Ss spoke all materials under: (a) normal conditions, (b) 110 db. white noise masking, (c) extensive local anesthesia of the oral cavity, and (d) masking and anesthesia combined. Stress and juncture patterns were correctly produced despite all feedback disruption, and there was no difference between naive and aware Ss. Noise masking produced a decline in speech quality and a disruption of normal rhythm, both of which were even more seriously affected by anesthesia and anesthesia plus masking. There were no significant vowel misarticulations under any condition, but there was nearly a 20% rate of consonant misarticulation under anesthesia and anesthesia and noise. Misarticulation was most severe for fricatives and affricates in the labial and alveolar regions, presumably because these productions demand a high degree of precision of articulate shape and location, and, hence, intact feedback. Results are discussed in terms of feedback-control mechanisms for speech production.

Kreul, E. James; Bell, Donald W.; Nixon, James C. Factors affecting speech discrimination test difficulty. Journal of Speech & Hearing Research, 1969, 12(2), 281-287.

Changes in item and overall test difficulty of speech discrimination and intelligibility tests as a function of (a) carrier phrase, (b) talker, (c) reutterances by a talker, and (d) level of accompanying noise were examined. Results with 23 junior college students indicate that all of these variables must be considered in test development. It is concluded that only the actual recordings of the spoken lists of words, not the word lists themselves, should be thought of as test material.

Kreul, E. James. Speech intelligibility for interaural alternated speech with and without intervening noise for words and nonsense. Language & Speech, 1971, 14(1), 99-107.

This research examined speech discrimination for 9 sophisticated listeners for the effect of interaural alternation of both word and nonsense syllable test materials in the presence and absence of intervening noise. No degradation of speech discrimination was noted for words without intervening noise; however, there was some effect for speech discrimination of nonsense syllable test materials. When intervening noise was employed difficulty in speech discrimination was noted for both the word and nonsense syllable test materials.

Nichols, Alan C. Effects of noise on articulation scoring: A methodical study. Journal of Communication Disorders, 1971, 4(3), 199-207.

A video-tape of children's responses to an articulation test was played once in the ambient quiet of a television studio, and once while electronically mixed with 5 conditions of broadband noise. The responses were scored by 14 trainees in speech pathology. Differences in scoring between the play and replay showed that (A) errors that could be heard in both quiet and noise decreased, and (B) more errors were obscured by noise as a function of greater noise levels. Responses scored as errors in noise, but not scored as errors in quiet, were maximized when the broadband noise was between 60 and 65 dB. It is concluded that the noise affected the listeners' judgements of the apparent defectiveness of the articulations they heard in complex and conflicting ways. Results illustrate the need for control of noise in experimental studies of articulation and in articulation testing.

Schwartz, Arthur Henry. The effect of variations in context of stimulus item presentation on speech sound discrimination performance under different listening conditions. (Doctoral dissertation, Vanderbilt University) Ann Arbor, Mich.: University Microfilms, 1972, No. 72-26,131, 164 pages.

The purpose of this study was to determine the effects of variations in the context of stimulus item presentation on speech sound discrimination performance under different listening conditions.

Subjects consisted of a total of 72 nursery, kindergarten, and first grade childred selected on the basis of successfully passing a battery of screening tests. These children were then divided into three equal groups on the basis of age.

Thirty monosyllabic nouns that were visually depictable in line drawings were selected as stimulus items. These items were presented to each subject in three different contexts and under a quiet and noise listening condition. A total of six subtests, representing each combination of context and condition, were compiled. All materials including instructions and practice items were presented via magnetic tape recording and through individual earphones. Mean number of error responses and mean latency of error responses were compiled for each of the six subtests. Several analyses of variance were performed to determine the effect of age, context, condition, and type of response alternative on performance.

The results of the present study indicate that both the context of stimulus item presentation and background listening conditions effected performance. There were significantly more errors in the paired comparison context than in the carrier phase or sentence context. There were more errors in the noise subtest for each context. However, noise seemed to have the most disrupting influence on performance when the stimulus items were presented in a paired comparison context. It was proposed that the presence of syntactic and phonetic cues facilitated performance in the carrier phrase and sentence contexts. However, no differences were found between the carrier phrase and sentence contexts with respect to number of errors. Analyses of latency of error responses revealed longest latencies for the paired comparison context and shortest latencies for the carrier phrase context.

When error responses were subdivided into type of response alternatives, it was found that listeners consistently made more errors in choosing foil words that shared many features with the target word. Similarly, it was found that it took less time to make an error involving the selection of a foil word that shared many features with the target word.

In conclusion, it appears that variables in the construction of speech sound discrimination tests do affect performance in young children. It seems that the syntactic components of language interact with the discrimination process in such a way to facilitate performance. Absence of familiar syntactic and co-articulatory components may present the young child with a unique and unfamiliar task, thus increasing the probability of error. This suggests a need to revise widespread practices of using a paired comparison context exclusively to assess speech sound discrimination.

Silverman, Franklin H. & Goodban, Marjorie T. The effect of auditory masking on the fluency of normal speakers. Journal of Speech and Hearing Research, 1972, 15(3), 543-546.

This research investigated the effect of masking noise on the disfluency frequency of 20 nonstuttering undergraduates. The majority of Ss became more fluent under this condition, suggesting that an increase in fluency when speaking in the presence of masking noise does not differentiate stutters from normal speakers.

Tobias, J.V. Binaural processing of speech in light aircraft. FAA Office of Aviation Medicine Report, 1973, 72-31, 6.

Symmetrical or asymmetrical signals were presented in a combination of phase relations by means of three loudspeakers suspended from the rear of the cabin ceiling in a light airplane. Ss were 5 women and 32 men who responded to words on modified-rhyme tests presented against a background of noise from the airplane (in level flight and at cruising speed).

Words were presented over 2 speakers at a time, and, in different conditions, the pairs of speakers were used in phase and out of phase. Lowest intelligibility scores were obtained when the speakers were in phase; highest scores were obtained when the speakers were out of phase. Improvement under the later condition was equivalent to approximately 2 db.

Wertz, Robert & Porch, Bruce. Effects of masking noise on the verbal performance on adult aphasics. Cortex, 1970, 6(4), 399-409.

Investigated the effects of auditory stimulation on the performance of adult aphasics in an attempt to clarify previous results. Previous investigations using auditory stimulation to improve speech in expressive aphasics show conflicting results, an attempt was made to resolve the existing confusion by having aphasics perform various naming and reading tasks during quiet and during stimulation with a continuous intense noise. Comparison of results obtained in quiet and in noise revealed no significant differences in accuracy or quality of response, but reduced latency during noise. Improvement, or the lack of it, was not related to the duration of aphasia or its severity, to minimal problems of auditory input, or to the amount of previous therapy.

Williams, William E. & Young, Donald D. An evaluation of four methods of monitoring simultaneous primary and secondary voice messages. Human Factors, 1967, 9(1), 45-52.

Four methods of monitoring simultaneous primary and secondary voice messages were investigated in high and low ambient noise environments. Two methods used a single earpiece headset and wall speaker, and 2 used a dual earpiece headset with either the primary message in one ear and the secondary message in the other ear, or the primary message in both ears and the secondary message in a single ear. A realistic script and operational setting were used to test the conditions using 54 trained Ss.

The dual-headset methods were found to be significantly superior to the headset/speaker method in most scoring categories. No significant differences were found between noise levels. The findings are compared with previous research on multimessage monitoring.

Wolfe, Asher Sorrel. The relationship between estimates of speech intelligibility in social contexts and paracusis Willisiana. (Doctoral dissertation, The Ohio State University) Ann Arbor, Mich.: University Microfilms, 1971, No. 72-4692, 98 pages.

This study was based on a widely accepted principle that listeners with conductive hearing losses hear speech better in noise than in quiet. In order to test this phenomenon, known as Paracusis Willisiana, an appropriate noise environment was recorded for use in four experiments. This noise, which was produced by many people speaking spontaneously and simultaneously, was named demophonic noise, for ease of reference in this study.

Stereophonic recordings of demophonic noise in a large cafeteria were made, and also of an announcer speaking four lists of monosyllabic words (CID Auditory Test W-22) in a soundproof room. Both recordings were made with two microphones in a dummy head. The two recordings were mixed electronically at three signal-to-noise ratios. The resulting test materials were played back stereophonically, monotically, and diotically both to listeners who had normal hearing and listeners who had bilateral conductive hearing losses.

Experiment I was performed only with listeners who had normal hearing in order to establish rank ordering of word intelligibility under four basic stimulus conditions, and to provide data that would relate to the reliability of abbreviated versions of the test material. Three additional experiments were performed with listeners who had bilateral conductive hearing losses. The obtained data were analyzed statistically, articulation functions were determined, and inferences were drawn on the basis of these functions.

The major findings of Experiment I, which was conducted in demophonic noise with listeners who had normal hearing, were:

1. The highest word intelligibility occurred during stereophonic

listening.

2. The lowest word intelligibility occurred during monotic two-channel listening.

3. Intermediate word intelligibility occurred during either monotic one-channel or diotic listening.

Experiment II was conducted in demophonic noise with listeners who had conductive hearing losses. The major finding was that these listeners performed almost as well as listeners with normal hearing when tested under identical stimulus conditions. Thus conductive hearing loss imposed only a slight handicap in the demophonic noise of this study, which was always constant at an average level of 78 dB, re .0002 microbar.

The foregoing information did not relate to a test of *Paracusis Willisiana*. Therefore, two additional experiments were conducted in order to compare word intelligibility in quiet and in demophonic noise. Experiment III was conducted both in quiet and in demophonic noise with listeners who had conductive hearing losses. The principal finding was that, when the talker's level remained constant, word intelligibility in quiet was obviously superior to word intelligibility in demophonic noise. Experiment IV was also conducted in quiet and in demophonic noise with listeners who had conductive hearing losses. In this experiment talker's levels in noise were more intense than in quiet in two of the three comparable stimulus conditions. Statistical analysis revealed no significant difference between word intelligibility in quiet and in noise. In summary, Paracusis Willisiana was not demonstrated as an auditory phenomenon in any of the experiments.

Viewed in light of available information about talker's levels in demophonic noise ranges of speech intelligibility in social contexts were estimated from the articulation functions in quiet and in demophonic noise. These estimates tended to indicate that Paracusis Willisiana, as a purely auditory phenomenon, occurs rarely, if at all.

Despite the results obtained in these experiments, some listeners with conductive hearing losses reported that they could hear speech better in noise than in quiet. A tentative explanation might be that when these listeners are very near the talker, as is much more usual in noisy surroundings than in quiet ones, they might be aided considerably by lipreading because of the higher visibility of the talker's face and mouth.

Young, I.M. & Harbert, F. Noise effects on speech discrimination score. Journal of Auditory Research, 1970, 10(2), 127-131.

This research studied effects of ipsilateral and contralateral presentation of masking noise on speech discrimination (DS) scores of 7 normal hearing Ss, 64 Ss with unilateral total hearing loss and normal hearing in the opposite ear, and 15 Ss with bilateral symmetrical hearing loss. Speech and noise were combined and presented monaurally. The normal and the bilateral loss group yield similar results: a DS greater than 70% when the signal/noise (S/N) ratio is +5 dB and higher, and less than 50% when the S/N ratio is -5 dB and lower. Ss with unilateral total hearing loss require a S/N ratio about 10 dB higher to approximate the DS obtained by normals.

TEMPORARY THRESHOLD SHIFT - PERMANENT HEARING LOSS

A great deal of research literature exists regarding Temporary Threshhold Shift (TTS) and permanent hearing loss in man. Principally, mention is made of the generally poor military noise environment (Carr, 1971) with conflicting evidence that submarine sonar technicians receive up to 118 dB via headphones (Harris, 1971), yet one study of tank crewmen indicated no TTS over an 18 month period (Spirov, 1969). Efforts should be made to control military noise at its source whenever possible. However, more adherence to noise regulations, and support for hearing conservation programs is mandatory (Carr, 1971). The civilian industrial sector studies offer proof that the potential costs to industry from noise are greater than for any other occupational disease (Alexander, 1968). Since man cannot adapt, legislation is needed. Some examples cited concluded that hazardous exposure levels are common to users of diving helmets and hyperbaric chambers (Summitt, 1971). Commercial flight crews (inspectors and pilots) show mild-to-moderate hearing loss, but stewardesses require 7000 plus hours to show increased thresholds (see Tobias, 1972, AUDIOMETRY). Even newborn are exposed to close to damage risk levels in many intensive care wards, with concern focused on the masking of possible important developmentally required sounds (Peltzman, 1970). Subjective affects of noise induced hearing losses are an intense sensation of deafness and a tinnitus (ringing in ears); complaints of headache, pressure in the head and increased sleep deprivation in combination with deafness and tinnitus (Wagemann, 1971).

Specific research on TTS indicates that up to 85-95 dB, TTS increases linearly with the log of the exposure duration. Above 95 dB, TTS increases become parabolic (Nakumura, 1967). Additionally, low frequency (5-8 Hz) vibration appears to increase TTS in combination with high intensity 101 dB broadband noise (Okada, 1972). Further human research yields changes in TTS due to spectral content of equal SPL profiles (Cohen, 1972). Work with chinchillas (which are more susceptible to noise than Rhesus monkeys) indicate that bands of noise produce equal TTS when noise levels are equated for the acoustic properties of the external and inner ears (Mills, 1972). However, Pinheiro, 1972, showed that impulse noise will destroy hair cells in the cochlea (monkey subjects) but, lower levels show the well known logarithmic recovery in addition to diaphasic, plateau and rebound recovery (Luz, 1970).

Alexander, Walter. Some harmful effects of noise. *Canadian Medical Association Journal*, 1968, 99(1), 27-31.

Noise constitutes a problem of increasing magnitude in our society and, indeed, one authority is of the opinion that the potential cost to industry of noise-induced hearing loss is greater than that of any other occupational disease. From an ecological point of view, noise induced hearing loss is a sympton of the failure of social integration in which man has met new environmental conditions for which his heritage does not provide adaptive capacity, and hence the need for legislative assistance, education and protection from the hazard of sound.

Benoay, Leroy W. Prevention of deafness from industrial noise and acoustic trauma. *Journal of the American Osteopathic Association*, 1968, 68(2), 161-167.

Noise does produce high frequency hearing loss. Instruments are currently available for determining whether or not noise in a given industrial plant is at a hazardous level; it is stressed that these should measure the components of different frequencies present in noise. Hearing conservation programs have been established by employers of more than 1/3 of those persons working in hazardous noise areas. Such programs attempt to conserve hearing and prevent hearing loss among workers, prevent economic loss to the company, and gather scientific information. Ideally, they would also involve the removal of noise at its source, by direct treatment of noise-generating machines and devices and by acoustic treatment of work areas. In areas where noise levels cannot be effectively reduced by currently available methods, specially designed ear devices can be used to protect the hearing of the worker. The medical aspects of these devices are explored with attention to anatomic, physiologic, and psychologic considerations.

Carder, Henry M. & Miller, James D. Temporary shifts from prolonged exposure to noise. *Journal of Speech & Hearing Research*, 1972, 15(3), 603-623.

Eight monaural male chinchillas were trained to respond to tones and their auditory thresholds measured. *S*s were exposed to octave-band noise centered at either .5 or 4 kHz. for periods of 2-21 days. Octave-band levels (OBL) between 65 and 105 db were used. The growth of temporary threshold shift (TTS) was measured during brief interruptions in the exposure. TTS increased for the first 24-48 hours of an exposure and then reached an asymptote and remained constant for as long as the exposure continued. At asymptote the relation between the TTS and the level of the octave band centered at .5 kHz. was TTS = 1.6 (OBL-65), where TTS was measured with a test tone of .715 kHz. at 4 min. after an interruption of the noise. Decay of TTS after termination of the exposure was slow and approximately exponential with a time constant of about 29 hr. Empirically, the time for TTS to decay to near-zero values ranged from 3-6 days. The course of decay of TTS was independent of the duration of the exposure once asymptote had been reached.

Carr, C. Jelleff & Fisher, Kenneth D. A review of adverse biomedical effects of sound in the military environment. *Technical Report*, 1971, 107 p.

The report provides a comprehensive review of the adverse effects of sound on man in the military environment. The diversity and complexity of army systems that overexpose the soldier to noise have caused concern for his health and his capability to perform efficiently. Despite the recognition of the deleterious effects of noise exposure, problems with noise-induced hearing loss and human performance decrement continue to enlarge. It is generally recognized that over exposure to high-intensity noise during a lifetime will result in progressive hearing loss. There is no way to correct permanent threshold shift.

Permanent hearing loss is irreversible. It is not possible at the present time to identify audiometrically individuals with increased susceptibility or resistance to injury from noise exposure. Protection by sound attenuating devices, such as earplugs or earmuffs, has proved to be the most practical way to protect and to conserve the hearing of men required to work in a noisy environment. Effective hearing conservation and reduction of noise induced hearing loss are compromised by lack of adherence to existing army regulations and frequent waiving of equipment design standards. Work should be directed toward reduction of noise at its source; and, emphasis should be placed on increased support for army hearing conservation programs. The report identifies research opportunities that are related to army needs.

Cohen, Alexander, Anticaglia, Joseph R. & Carpenter, Paul L. *Journal of the Acoustical Society of America*, 1972, 51(2 Pt. 2), 503-507.

Sound-level measurements in the dBA were investigated to determine if they could adequately depict harmfulness to hearing from exposures to noises differing widely in spectra. Eleven 20-26 year old male listeners were exposed in separate sessions to each of 3 noises whose spectral slopes were -6, 0, and +6 db/oct band, and then reexposed to the same noises in 3 additional sessions. All noises were presented for 30 min. by earphone at 100 dbA. Analyses of variance of the temporary threshold shift, corrected to 2 min. postexposure (TTS2), showed insignificant differences owing to the spectral variations for both test and retest conditions as averaged across audiometric frequencies 250-8,000 Hz. Interactive effects between spectra and test frequencies were significant, the -6- and 0-db. spectral conditions causing relatively more TTS2 at frequencies above 3,000 Hz. Implications for noise hazard rating schemes using dbA measures as contrasted with spectral determinations are discussed.

Cohen, Alexander & Jackson, Emanuel. Threshold shift in hearing as a function of bandwidth and mode of noise presentation. *Journal of Auditory Research*, 1968, 8(4), 401-414.

Fifteen *S*s were each exposed to three bandwidths of fatiguing sound presented under three intensity level conditions. The Committee on Hearing, Bioacoustics and Biomechanics (CHABA) has established equinoxious criteria for exposures to differing bandwidth intensity noise combinations. The present study viewed the adequacy of these criteria by exposing 15 *S*s to each of 9 experimental conditions and recording the resulting temporary threshold shifts (TTS). Results suggest that the CHABA criteria may be conservative. Implications of these findings with reference to both critical band -TTS notions and acoustic reflex action are noted.

Feldman, H. Homolateral and contralateral masking of tinnitus by noise bands and by pure tones. *Audiology*, 1971, 10(3), 138-144.

A series of tests was conducted using approximately 230 patients suffering from tinnitus. Results indicate that tinnitus was masked by broad band noise, narrow band noise, and pure tones. The levels necessary for masking formed 5 characteristic patterns. Ultimatu tinnitus was usually inhibited by stimulation of the contralateral ear. When using interrupted stimuli, inhibition was effective in the intervals up to a certain length, dependent on various parameters.

Gasaway, Donald C. & Sutherland, Harrell C. Application of current auditory damage risk criteria to aerospace operations. *School of Aerospace Medicine Technical Report*, 70-36.

Valid and realistic criteria are needed for identifying and determining potentially hazardous noise encountered during ground and airborne aerospace operations. A set of criteria proposed by a working group on hearing, bioacoustics, and biomechanics, has been modified for easier interpretation and use in assessing auditory risk. An auditory risk calculator has been devised to simplify the task of assessing wide-band and narrow-band noise exposures. In addition, a simple chart has been prepared for use in evaluating intermittent noises. Examples of noise exposures encountered in aerospace operations are illustrated and applications of the three basic types of auditory risk criteria are demonstrated. Desirable and undesirable features of older and newer criteria are discussed.

Harris, J. Donald & Lacroix, Paul G. Reduction in audiogram shifts in sonar watchstanders when exposed to surface ship echo-ranging. U.S. Naval Submarine Medical Center Memorandum Report, 1971, 71-4, 8 p.

Audiograms collected underway on sonar technicians on the submarine USS GATO (SSN 615) during exposure to echo-ranging 19-31 January 1971 showed that SPLS in the sonar headsets may be hazardous to hearing. Two of 3 headsets were modified so as to limit the peak SPLs delivered to the ear. On a cruise 21-31 March 1971, during which light to moderately heavy echo-ranging was encountered, 6 men using an unmodified headset, were exposed to SPLs up to 118 db. In 1/2 of the Ss, a temporary hearing loss was found which exceeded a widely-disseminated damage-risk criterion. However, of 6 Ss who used modified headsets, no average loss whatever was found, and only one ear slightly exceeded the criterion. Whether the modification introduced on this occasion was an optimal compromise between protecting the ears vs. obtaining all possible information from the sea, is still an open question.

Hickling, S. Experimental studies relating to the SISI test. Journal of Auditory Research, 1968, 8(4), 477-481.

Studies were undertaken to determine the effect of induced conductive temporary threshold shifts and of noise-induced temporary threshold shifts on the lowest SPL of the steady tone (Short Increment Sensitivity Index SISI threshold) at which a positive SISI response could be obtained. The effect of a conductive shift was to elevate the conventional threshold and the SISI threshold equally. The effect of a noise induced shift was to elevate the SISI threshold by a small amount regardless of the degree of conventional audiometric shift. This small SISI threshold shift is thought to represent a small and constant component of noise-induced temporary threshold shift (TTS) which is retrocochlear in origin. Considering the possibility that the SISI threshold concept might be applicable in clinical practice, the test-retest reliability of threshold measurements and their validity in relation to a norm were evaluated. Although poorer than for corresponding values from conventional audiometry it was considered that they could be adequate for this purpose.

Luz, George A. & Hodge, David C. Recovery from impulse induced TTS in monkeys and men: a descriptive model. *Human Engineering Labs Aberdeen Proving Ground, MD*, 1971, Report No. HEL-TM-11-71.

The recovery from impulse-noise induced temporary threshold shift was systematically traced for individual rhesus monkeys and men. In addition to the well known logarithmic recovery, three other types of recovery were seen (diphasic, plateau, and rebound). A descriptive model is developed for the classification of these recovery functions. The model postulates the existence of two types of temporary threshold shift, process M and process S, both of which may be seen after impulse-noise exposure.

Luz, George A. & Mosko, James D. The susceptibility of the chinchilla ear to damage from impulse noise. *Army Medical Research Lab Fort Knox Ky*, 1971, Report No. USAMRL-921.

Five monaural chinchillas were exposed to impulses of 168 dB SPL, and the loss of sensitivity for the pure tones of .3, .75, 1.5, 4.0, 6.0, 7.9, 11.0, 14.5, and 16.5 KHZ was determined through an avoidance conditioning technique. The recovery of sensitivity was studied over 64 days after exposure. The chinchillas proved to be much more susceptible to this noise than the rhesus monkey.

Mills, John H. & Talo, Seija A. Temporary threshold shifts produced by exposure to high-frequency noise. *Journal of Speech & Hearing Research*, 1972, 15(3), 624-631.

Four trained monaural chinchillas were exposed for 24 days in a diffuse sound field to an octave-band noise centered at kHz. The octave-band levels (OBL) were 57 db for Days 1-6, 65 db for Days 7-12, 72 db for Days 13-18, and 80 for Days 19-24. At regular intervals throughout the noise exposure each *S* was removed from the noise and threshold measurements were made. For each noise level, temporary threshold shift (TTS) reached an asymptote. In the frequency region of maximum effect, the relation between TTS and noise level is given by the equation TTS = 1.6 (OBL-47). Results for noise centered at 4 kHz, in combination with those results for a noise centered at .5 kHz, suggest that bands of noise produce equal TTS when noise levels are equated for the acoustic properties of the external ears.

Nakamura, S. & Katano, Y. Relationship between temporary threshold shift and duration of noise exposure. *Journal of Auditory Research*, 1967, 7(4), 401-411.

Temporary shift (TTS) damage-risk criteria are established for the parameter of duration of exposure to various noise bands. Four octave bands of noise (281-561, 561-1122, 1122-2245, and 2245-4490 cps) and broad band noise were applied to 6 normal *S*s. Exposure intensity ranged from 60-100 db. sensation level (SL), and duration from 5-240 min. Not all possible combinations of conditions were used. As long as SL did not exceed a limit, which varied from 85-95 db. SL, TTS increased linearly with the logarithm of exposure duration; as SL exceeded the limit, the rate of increase of TTS became parabolic upward.

Okada, Akira; Miyake, Hirotsugu; Yamamura, KotaroMinami, Masayasu. Temporary hearing loss induced by noise and vibration. *Journal of the Acoustical Society of America*, 1972, 51(4, Pt. 2), 1240-1248.

Gave 5 normal hearing male 19-20 yr. olds exposures to (a) steady-state noise, (b) vibration, and (c) noise and vibration at the same time. In a control experiment the S sat beside the moving vibrator with earplugs and earmuffs. Temporary threshold shift (TTS) occurred after both 20 and 60 min. of exposure to the vibration of acceleration 500 cm/sec2 and frequency 5 Hz. which is regarded as a resonance frequency of human body. The TTS by a steady-state noise (101-db SPL broad band) was increased by simultaneous vibration (500 cm/sec2 and 5 Hz.).

Outz, James W. Auditory temporary threshold shift (TTS) following exposure to high-intensity and variable-peaked farm machinery noise. *Journal of Auditory Research*, 1969, 9(1), 64-70.

Noise from three types of farm machinery was recorded binaurally to 27 normal hearing young adults for 15 minutes under each of three "peak factor" conditions. The "peak factor" was tailored by the E as the ratio of instantaneous peak pressure observed on an oscilloscope to the root-mean-square (RMS) pressure of the complex sound wave. Bekesy postexposure threshold tracings at 4 kcps were obtained for 7 min.; mean TTS over this time was taken as the index of TTS. Within each type of noise, at the same SPL, a critical factor exists at and above which TTS may become significant; these critical factors must be taken into consideration when predicting TTS from complex noises.

Peltzman, P., Kitterman, J.A. & Ostwald, P. F. Manchester, D. Effects of incubator noise on human hearing. Journal of Auditory Research, 1970,10(4), 335-339.

The maximum readings on a sound level meter were about 75 dbC. in the intensive care room of a new born baby nursery. Overall and band-limited spectral analyses of the noises inside individual incubators showed that one unit at 250 cps approached widely-acceptud damage-risk criteria. The average threshold shift of 12 young normal-hearing adults exposed to this noise was about as predicted from the acoustic spectrum and from classic masking data. One S, exposed to this noise for 45 min., showed no measureable TTS at any frequency. It was suggested that the noise, while not probably damaging, may yet be enough to mask out sounds which the infant, in this critical period of life, might use for development of sensory and social differentiations and perhaps even for speech and language acquisition.

Pinheiro, Marilyn, Jordan, Valdemar, & Luz, George A. The relationship between threshold shift and the loss of hair cells in monkeys exposed to impulse noise. Army Medical Research Lab Fort Knox Ky, 1972, Report No. USAMRL-990.

A comparison of permanent threshold shift sustained by monkeys exposed to impulse noise with hair cell and nerve fiber loss in their inner ears demonstrated that impulse noise damages the cochlea by destroying hair cells in a restricted area. This destruction was not disclosed by pure audiometry until there was a severe loss of outer hair cells extending over several millimeters of the basilar membrane, the overall correlation between the two measures of damage (audiometric and histological) was statistically significant. Individual deviations were hypothesized to be due to the redundancy among the population of sensory cells in the inner ear, spread of excitation as a function of intensity, release from inhibition or masking, and a possible change in the elasticity of the denuded basilar membrane which might have affected the traveling wave pattern.

Sommer, Henry C. The combined effects of vibration, noise, and exposure during on auditory temporary threshold shift. *Aerospace Medical Research Lab Wright-Patterson AFB Ohio*, 1973, Report No. AMRL-TR-73-34.

To determine the combined effects of noise and vibration on auditory function, the temporary threshold shifts (TTS) of two groups of 10 subjects each were measured as a function of intensity and duration of exposure. Combined noise and vibration was presented to one group for 5 minutes and to the other for 20 minutes. Both groups were exposed in the Z axis at frequencies of 9 HZ (peak) and 0.950 GZ, respectively. Noise levels of 90 dB and 100 dB were presented simultaneously with the vibration. TTS was measured at post exposure recovery times of 0.5,2.0, 5.0, 10.0, and 20.0 minutes. Although the mean difference was small (0.72 dB), a significantly larger TTS was obtained at 9 HZ than 18 HZ vibration, and 100 dB produced a larger TTS than 90 dB. Significant differences in TTS were also obtained as a function of duration of exposure and as a function of post exposure recovery time.

Spirov, Aleksandar Results of examination of hearing lesions in tank crew and infantrymen. *Vojnosanitetski Pregled*, 1969, 26(2), 78-80.

On the basis of examination and control of 122 soldiers from infantry and tank units exposed to noise it was found that an 18-mo period was insufficient to provoke professional damages of hearing.

Summitt, James K. & Reimers, Stephen D. Noise : a hazard to divers and hyperbaric chamber personnel. *Navy Experimental Diving Unit Washington, D. C.*, 1971, Report No. NEDU-RR-5-71.

Series of experiments conducted at the Navy Experimental Diving Unit to determine the sound level in a variety of helmet diving and hyperbaric chamber situations from the surface to a depth of 200 feet. Data is defined in terms of hearing damage risk criteria currently in use by the Navy. Results indicate that operations involving both diving helmets and hyperbaric chambers frequently expose personnel to hazardous levels of noise depending on the length of time of the exposure. Three cases of temporary sensorineural hearing loss thought to be related to noise exposure during air helmet dives are also presented.

Wagemann, W.*Subjective complaints of noise-induced hearing loss.
Army Foreign Science and Technology Center Charlottesville, Va.,
1971, Report No. FSTC-HT-23-242-71.

The investigations of initial and later subjective complaints of noise induced hearing loss are reported. The main complaints are: an intense sensation of deafness and tinnitus, which in part are reported together. Complaints are made of headache both by itself and in combination with the sensation of deafness. The sensation of pressure in the head occurs exclusively in combination with the sensation of deafness. Increased sleep deprivation occurs only in combination with deafness and tinnitus.

VIGILANCE

Vigilance continues to be an area of concern for noise researchers. The primary variable investigated is the effect of noise on various vigilance tasks. For example, Blackwell & Belt (1971) investigated three levels of continuous white noise and found no differential effects of the noise on a vigilance task. However other investigators (Warner & Heimstra, 1971; 1972; O'Malley & Poplawsky, 1971) demonstrated that noise does have differential effects on vigilance performance depending on the difficulty of the task and the way the noise is presented.

Childs & Holcomb (1973) suggest that the type of response required may also affect the performance, with increased complexity of response aiding in signal detection.

Bernstein & Eason (1970) and Fidell (1970) have shown that Ss perform better in a vigilance task when the information is presented in two sensal modes. Both studies used vision and audition. Davies, Garland and Shackleton found that music aided performance in a difficult vigilance task.

Bernstein, Ira H. & Eason, Thomas R. Use of tone offset to facilitate reaction time to light onset. *Psychonomic Science*, 1970, 20(4), 209-210.

Four undergraduates participated in a visual discriminative RT task to explore the phenomenon of intersensory facilitation. Previous research has indicated that RT to a joint visual-auditory event is more rapid than RT to the visual component alone, even when the auditory component is noninformative. In the present study, a tone offset was used in place of the usual affirmative event (click). Results indicate that RT is more rapid when the tone offset is in conjunction with the occurrence of the visual event as compared to when the tone remained on throughout the trial. The effect was comparable in magnitude to that obtained in prior studies using an affirmative auditory event.

Blackwell, P. J. & Belt, J. A. Effect of differential levels of ambient noise on vigilance performance. *Perceptual & Motor Skills*, 1971, 32, 734.

Ambient white noise is often used in a vigilance task to mask equipment and extraneous noise. However, an acceptable level has not been established and a wide range of intensity levels has been used. The question of whether the intensity level of ambient white noise has any effect on vigilance performance was investigated. Results indicate no significant difference between the noise levels of 50, 75, and 87 dB.

Brown, John. Recognition and the direction of attention. *Acta Psychologica, Amsterdam*, 1970, 33, 149-157.

Four experiments with 20, 10, 10, and 20 *S*s are described which tested the hypothesis that the mechanism of attention enables unwanted inputs to be attenuated. In Exp I., two words were presented simultaneously, one to each ear, in uncorrelated noise. In a recognition test the *S* then attempted to select the word which had been presented to a designated ear. Under a *k* condition, the ear was designated in advance and under and *nk* condition it was designated only in the test itself. It was argued that, if a filter mechanism can attenuate unwanted inputs and if noise with the input adversely affects buffer storage at a sensory level, then recognition should be superior under the *k* condition. However no difference between the conditions was found. In Exp. II, omitting the word to the unwanted ear had a highly favorable effect on recognition, thus showing that there was plenty of scope for attenuation of the unwanted input to improve performance in Exp. I. Exp. III repeated Exp. I but with noise-free inputs. Exp. IV was similar to Exp. I except that, instead of using a visual signal to try to switch-in the appropriate ear under the *k* condition, an auditory signal was given to the ear concerned. Negative results were again obtained. Explanations for this failure to support the hypothesis are discussed. One is consistent with a subsidiary finding that words were not tagged effectively by ear-of-arrival and a further experiment to test the hypothesis is suggested.

Childs, Jerry M. & Halcomb, Charles G. Effects of noise and response complexity upon vigilance performance. *Perceptual and Motor Skills*, 1972, 35(3), 735-741.

Visual vigilance performance was investigated with respect to environmental stimulation (90-dB, 1000 cps noise) and intra-organismic stimulation (simple vs complex response). One hundred undergraduates monitoring a display for one hour under one of two noise types were instructed either to press a button upon detection of a periodic signal (simple response) or to additionally perform a checklist operation subsequent to the signal detection (complex response). Significant correct detection differences occurred between response groups with complex groups showing high performance ($p < .05$). Mean differences in correct detection were obtained for noise conditions (continuous = 83%; intermittent = 78.5%). Results are evaluated in terms of the activation hypothesis.

Davies, D.R. Garland, Lesly & Shackleton, V.J. The effects of music and task difficulty on performance at a visual vigilance task. *British Journal of Psychology*, 1974, 64(3), 303-309.

Forty, 18-28 undergraduates performed a difficult or easy visual vigilance task in music or noise. Response measures taken were correct detections, commission errors, detection latencies, and d'values. For the difficult version of the task a significant increase in detection latencies was found which music prevented. Broadly similar findings were obtained for correct detection. Results are compared with other studies of detection latency and task difficulty and are discussed in terms of arousal.

Fidell, Sanford. Sensory function in multimodal signal detection. *Journal of the Acoustical Society of America*, 1970, 47(4, Pt. 2) 1009-1015.

Five female undergraduates were tested on a two-interval forced choice task involving the detection of a sinusoid in noise, where the signal could occur on an earphone, an oscilloscope, or both devices simultaneously. Detection performance was studied as related to (a) mode of occurrence of the signal (s), (b) the external noise correlation in the auditory and visual channels, and (c) *S*s a priori knowledge of the mode of occurrence of the signal. Improvement in sensitivity (measured in d' units) as a function of bimodal signal presentation closely followed the predictions of a statistical summation model and was much lower than predicted by linear and probabilistic addition models. Under conditions of independence of noise in the auditory and visual channels, some improvements in sensitivity were of almost three dB. Improvement in sensitivity afforded by a priori knowledge of the mode of occurrence of the signal was less for bimodal signals than for unimodal signals.

Green, David M. & Luce, R. Duncan. Detection of auditory signals presented at random times: III. *Perception & Psychophysics*, 1971, 9(3-A), 257-268.

RTs of three *S*s to a pure tone in noise were measured. Throughout, the time from the warning signal to the reaction signal was exponentially distributed, and the signal was response terminated. Response criterion, signal intensity, and mean foreperiod wait were varied. A model that assumes a Poisson sensory transduction, a pulse-activated decision process, and an additive bounded residual process, was tested. It is concluded that the assumed decision process was in error. Among the empirical results, the dependence of mean RT on signal waits was shown to depend largely on the average wait, not the actual one, and that this relationship between mean RT and average stimulus wait increased for strong signals and decreased for weak ones.

Gulian, Edith. Auditory vigilance under noise conditions: Psychophysiological correlations. *Studia Psychologica*, 1971, 13(2), 114-120.

The effects of noise upon auditory vigilance and its physiological concomitants were studied in fifteen 19-30 yr. olds during five experimental sessions. Performance measures (RTs, GSRs, and EEGs) were recorded. Modifications of behavioral vigilance and the other indicators under quiet and different levels (70 and 90 dB) and types (continuous and intermittent) of noise were investigated. Results indicate a certain dissociation between

EEG, GSR, and behavioral activation, but the concordance of all measures varied as a function of the degree of stress.

Harris, C. Stanley & Filson, George W. Effects of noise on serial search performance. USAF AMRL Technical Report, 1971, 71-56, 27 p.

Broadbent's statements concerning the necessary conditions for demonstrating an adverse effect of noise on human performance were evaluated in a test of 70 Ss on a serial search task. Performance was measured during broadband noise exposure at an overall level of 105 db re .0002 dyne/cm^2. One group of Ss was tested for 36 minutes with two, 3 minute interpolated rest periods, while another group was tested for 36 consecutive minutes with no rest periods. The performance of these groups was compared with that of comparable control groups for five days. Noise produced a statistically significant reduction in the number completed for the rest group for the first 12 minutes of testing on each day. There were no significant differences between the noise and control group during the last 24 minutes of testing. For the no rest groups, noise resulted in a statistically significant smaller number of items completed on the last two days of testing. On these days, the effect was constant throughout the 36 min. of testing. Results are interpreted as generally supporting Broadbent's position.

O'Malley, John J. & Poplawsky, Alex., Noise-induced arousal and breadth of attention. Perceptual and Motor Skills, 1971, 33(3), 887-890.

The effect of intermittent noise upon attention span was investigated. In Exp. I with 44 male undergraduates, 4 levels of noise intensity were used: 0,75,85 and 100 db. The task was a serial anticipation task in which the relevant stimuli were 4-letter words located in the center of a projected slide. Three letter words were peripherally located and were not mentioned to the Ss. Ss in the 85- and 100- db conditions learned fewer of the peripheral words as indicated by a free-recall test, indicating a narrowing of attention due to the higher noise levels. In Exp. II with 30 female nursing students, Ss operating under 85-db noise performed significantly better on the Stroop Color Word

Test than did Ss operating under no noise, again indicating a focusing of attention due to noise-induced arousal. Results are consistent with the proposal that increased emotional arousal causes a narrowing of attention.

Pastore, Richard E. & Sorkin, Robert D. Simultaneous two-channel signal detection: I. Simple binaural stimuli. Journal of the Acoustical Society of America, 1972, 2(2, Pt. 2), 544-551.

Two experiments were conducted in which two female college student Ss performed two simultaneous increment detection tasks, one in each ear. This task, together with monaural and binaural control conditions, was used to investigate interaural time sharing, sensory interactions, internal noise, and binaural decision spaces. When the signals were binaurally in phase, there was no evidence of cross-channel facilitation or inhibition, and Ss were able to perform the task without performance decrements relative to single-channel control conditions. For one S, the derived estimate of the between-channel correlation in the absence of an external masking noise was +.40 and was consistent across different experimental conditions. Differences in the results for 180 phase-shifted signals indicate probable changes in the nature of the processing mechanisms involved in the detection of the different types of signals. It is concluded that the paradigm and related analyses should be of value in the study of other kinds of perceptual phenomena.

Thurmond, John B., Binford, John R. & Loeb, Michel. Effects of signal to noise variability over repeated sessions in an auditory vigilance task. Perception & Psychophysics, 1970, 7(2), 100-102.

Thirty-two paid undergraduates listened to a sequence of Gaussian noise pulses of .5-sec duration, occurring at 2.5-sec intervals. Performance was compared under two conditions: One group detected the occurence of a 1.8-dB increment in noise pulses; a second group detected the occurrence of increments of 1.3, 1.8, or 2.3 dB. All Ss performed for three 90-min. false alarms. Theory of signal detectability indices, d' and BETA were also derived. It was found that d' increased slightly over sessions and decreased almost negligibly during sessions, and criterion indices and BETA increased both within and over sessions. Performance was comparable under the fixed- and mixed-signal conditions.

Warner, Harold D. & Heimstra, Norman W. Effects of intermittent noise on visual search tasks of varying complexity. Perceptual & Motor Skills, 1971, 32(1), 219-226.

Four noise ratios were utilized: 0, 30, 70 and 100% noise on-time in successive 5 second intervals. The task required that Ss search a display for a single letter located among a larger background of letters which were all the same but different from the single letter. Task complexity was varied by changing the number of background letters. Two difficulty levels were utilized: 8 and 32 letter displays. Twenty-two male college students were tested under all conditions specified by the Task Complexity * Noise Ratio matrix. Detection speeds for the 32 letter task condition were faster for any ratio of noise than in the control condition but for the 8-letter condition only the 30% noise ratio was faster than the control. The speeds for the 70 and 100% ratios were slower for the 8-letter condition. The order of the 30, 70, and 100% ratios, however, without the control comparison, indicated that the relative differences between noise effects were the same for both levels of task complexity. The order of conditions beginning with fastest was: 30, 100, and 70%.

Warner, Harold D. & Heimstra, Norman W. Effect of noise on visual target-detection performance. Human Factors, 1972, 14(2), 181-185.

The effects of several intensity levels of continuous white noise were examined in a target-detection task with 70 male undergraduates having normal hearing and vision. Variables manipulated were noise-intensity level, display-difficulty level, and target location. The four noise levels utilized were: 0 (used as a control condition), 80, 90, and 100 dB. Display difficulty was defined in terms of number of nontarget, or background, display elements on three levels of difficulty, 8,16, and 32 background letter characters. The central and peripheral region of the visual display were examined, and detection time and error recorded. Results indicate that noise-intensity and display-difficulty level were significantly interrelated with respect to detection speed but not to detection error.

NOISE MEASUREMENT AND AUDIOMETRY

The primary areas of investigation have centered on perceived judgements of the aversiveness of noise as measured in laboratories utilizing improved methods of rating noisiness such as Effective Perceived Noise Level (EPNL) used by Pearsons (1971) rather than Perceived Noise Level (PNL) to more accurately rate aircraft noise. A-weighted noise measurements appear to be generally adequate descriptors of transportation noise levels except in instances where pure tones exist in jet aircraft noise (Serendipity, 1970). Stevens (1972) has completed a new procedure for calculating Perceived Level dB using the Mark VII method with a new reference of loudness defined as a 1/3-octave band centered at 3,150 Hz. Generally the perceived magnitude doubles with each 9 dB increase in SPL.

A large body of research deals with various comparisons of white noise as a reference for aversiveness measures. Chapman (1971) found that at 60 dB, white noise is judged louder than speech of the same intensity, but that above 70 dB speech is judged louder. Sullivan (1970) found that thresholds for the attribute of aversive loudness can be effectively specified in the laboratory, and Berglund (1973) demonstrated that laboratory developed scales for judging loudness show aircraft noise is more annoying than noisy and more noisy than loud.

Noise duration, time intervals and Doppler effects have been investigated to determine their respective influences on perceived loudness. Perry, (1972) found that only when noise is above the Speech Interference Level (SIL) is duration a factor in community annoyance. Rosinger et. al.(1970) found that approaching sounds generated by aircraft flyovers were judged more annoying than receding sounds of equal intensity. Schneider (1972) worked with time between stimulus presentations set at 24 hours to determine magnitude estimation differences with findings that show more variance and lower perceived intensity as a result.

Another large area of concern deals with the use of loudness contours as standards for noise control. Recent work by Beranek (1971) on the old

Noise Criterion (NC) curves indicates that they may be misleading as a standard and potentially allow excessive low and high frequency noise to exist while technically meeting the specified NC curve. Using S.S. Stevens Mark IV method, new Preferred Noise Criterion (PNC) curves have been developed. PNC standards lower by 2-5 dB noise allowed below 125 Hz and above 1000 Hz. These findings are supported by Ohlerhead (1969).

From an applied standpoint, findings by Kanda (1970) lead to the recommendation that ships should change warning horns to a higher fundamental frequency, and Sidova (1970) found that general excitability of children in day nurseries is correlated to the noise levels present.

Finally, Hodge (1972) recommends that the military revise noise criteria from decibels of hearing loss to more meaningful predictions about performance of military people after exposure to noise. This type of criterion would be of more practical assistance to key decision makers who generally may not be familiar with hearing loss criteria.

Beranek, Leo L., Blazier, Warren E., & Figwer, J. Jacek. Preferred noise criterion (PNC) curves and their application to noise. *Journal of the Acoustical Society of America*, 1971, 50(5, Pt. 1), 1223-1228.

The noise criterion (NC) curves were developed both as a method for evaluating existing noise situations and as a means for specifying design goals for noise control. They have also influenced the N ratings used abroad. It has been demonstrated that if a background noise whose spectrum conforms to an NC-curve shape is deliberately generated, it does not sound to a listener as a pleasant or neutral noise, but is both "hissy" and "rumbly". A recent tendency in consulting practice, therefore, has been to specify noise levels that are lower than NC curves at both low and high frequencies. Also, the original NC curves were derived using S.S. Stevens' Mk I method of calculating loudness level from noise levels measured with the old octave bands, the lowest of which was the "below 75 Hz" band. A reexamination of the noise criterion curves has undertaken using Stevens' Mk. VI method and the new octave bands.

The result is a new set of curves, called "preferred noise criterion (PNC) curves", having levels in the bands below 125 Hz. and above 1,000 Hz. that are lower than those of the 1957 NC curves by 2-5 dB. The new set also considers the engineering realities of achieving the specified noise levels with conventional air-handling equipment. Results of a number of recent noise-control projects in buildings are presented for comparison.

Berglund, Birgitta, Berglund, Ulf & Lindvall, Thomas. Scaling loudness, noisiness, and annoyance of aircraft noise. *Stockholm University (Sweden) Psychological Labs*, 1973, Report No. 393.

The capacity of man to differentiate and scale aircraft noise with regard to three attributes frequently used in social survey research on ambient noise was tested. A two-step psychological scaling procedure was adopted that produced calibrated scales for the attributes. Further, instructions were designed that carefully defined the meaning of the attributes to the subjects. It was demonstrated that subjects in such carefully designed laboratory situations are able to use and produce scales of loudness, noisiness, and annoyance for aircraft noise. The results consistently showed that aircraft noise is more annoying than noisy and more noisy than loud. The data on the relationships between pairwise attributes were well described by linear functions but a mechanism of inter-attribute power transforms could not be rejected.

Chapman, A. J. & Cumberbatch, W. G. Relative loudness judgments of non-shadowed material presented dichotically. *Perceptual & Motor Skills*, 1971, 32(1), 79-82.

In a nonshadowing dichotic loudness judgement task, 20 male university students matched speech and white noise intensities at 60, 70, 80, 90, 100, and 110 dB. above 70 db., *Ss* judged speech to be louder than white noise, at 70 db. they were judged to be equally loud, but at 60 dB. white noise was considered to be louder than speech. These findings are discussed in terms of the attenuability of different types of material.

Hodge, David C. Improved weapon noise exposure criteria. *U.S. Army Human Engineering Laboratories Technical Note*, 1972, No. 1-72, 13 p.

Reviews the state of the art in noise-exposure criteria and suggests that such criteria are in need of revision and extension to meet future operational requirements of the army. It is recommended that existing noise criteria, expressed in terms of "decibels of hearing loss" should be restated in terms of predictions about the performance of military personnel after they have been exposed to noise. Such restatement in performance terms will significantly improve communication about the risk of noise exposure to people who are in a position to utilize such information but who generally do not comprehend the notation of decibels of hearing loss.

Kanda, Hiroshi, Oguro, Hideo & Ohara, Takehumi. Fundamental frequency of signal sound and audible distance. *Journal of Science of Labour*, 1970, 46(2), 80-125.

In estimating the audible distance of the signal sounds issued from ships this research considers the divergence decrease due to the spreading of sound waves from a point source, the masking effect of environmental noise on the signal sound, and the attenuation due to absorption and the shadow zone created by the bending of sound waves caused by atmospheric conditions. When the environmental noise of the side of the source signal sound is too loud, the signal sound is masked by the environmental noise and it cannot be heard unless it has an adequate SPL. Results suggest that ship's signal sounds with a higher fundamental frequency than that used by ships in the past are necessary for more effective signaling.

Namba, Seiichiro, Nakamura, Toshie & Yasuda, Sonoko. On the loudness Of level-fluctuating noises. *Japanese Journal of Psychology*, 1971, 42(2), 93-103.

The regulating factors in perception of level-fluctuating noises were investigated. Fluctuating noises were generated by systematically changing the physical intensity of white noise, and perceived loudness determined by having *S*s match them with the loudness of level-fixed noises. A relationship was found between the physical intensity and perceived loudness of level-fluctuating noises. *S*s reported that it was not difficult to match loudness of fluctuating and fixed noises, and intraindividual variance was small. Perceived loudness of fluctuating noises changed with the width of the level-fluctuating range. It is concluded that the data are not complete enough to suggest a model of noise perception.

Ollerhead, J. B. The noisiness of diffuse sound fields at high intensities. *Wyle Labs Huntsville Ala.*, 1969, Report No. WR-69-17.

An experimental study was conducted to establish the relationships between the subjective noisiness, frequency and sound pressure level of random noise in a diffuse acoustic field. The experiments were performed in a fabric enclosure installed within a 100,000 cubic foot reverberant chamber. Twenty-four subjects took part. The growth of noisiness with sound pressure level of an octave band of noise centered at 1000 Hz was determined. The variation of noisiness with frequency was measured at four perceived noise levels between 78 and 104 PNdB. For comparison purposes, one equal noisiness contour was also determined for free field listening conditions in a progressive wave chamber. The results indicated that currently used noisiness growth functions are adequate but that the equal noisiness contours may need some modification at low frequencies. Also the contour shapes vary as sound pressure level increases indicating relatively greater noise sensitivity at both high and low frequencies.

Parry, H.J. & Ends, E.J. *Study of improved methods for predicting human response to aircraft noise: magnitude estimation test. *Lockheed-California Co Burbank*, 1972, Report No. LR-24985.

Laboratory determinations of the effect of duration on the judged acceptability of noises have produced conflicting, if not confusing, results. Further, there is the question of application of so-called duration corrections to the prediction of community response to vehicle noises. This develops the very strong implication that judging duration in terms of equivalent noise levels is, in reality, a type of cross-modality experiment wherein the subject is simply measuring duration. There is some evidence also that only above the speech interference level is the community concerned with noises of different duration. An experiment designed to resolve the possible interactions between different main noise descriptors (annoyance, loudness, noisiness, acceptableness) and duration cues is described. Results indicate that duration cues do have a significant effect on judgements of noises having varying duration. Further, the data indicate that the calculation procedures PNL, PNLT and EPNL correlate better with the results for some descriptors than with others.

Pearsons, Karl S. & Bennett, Ricarda L. Effects of temporal and spectral combinations on the judged noisiness of aircraft sounds. *Journal of the Acoustical Society of America*, 1971, 49(4, Pt. 1) 1076-1082.

The effects on perceived noisiness of spectral and temporal combinations of stimuli were determined at varying durations in an anechoic chamber. *Ss* were 20 undergraduates. Several recordings of turboprop, turbofan, turbo-jet, and helicopter flyovers were also included in the list of stimuli. Results indicate that the most accurate predictor of the judged noisiness was perceived noise level with tone and duration corrections as outlined by the 1968 Federal Aviation Administration (FAA) aircraft certification procedure. To illustrate the responsiveness of effective perceived noise level (EPNL) over perceived noise level (PNL) in predicting the noisiness of stimuli, the results of the duration test reveal that, at judged equal noisiness, 75% of the data were within 4 dB. of the standard signal for EPNL with the FAA and integrated duration measure as compared to 11 dB. for PNL.

Rosinger, George, Nixon, Charles W. & von Gierke, Henning E. Quantification of the noisiness of "approaching" and "receding" sounds. *Journal of the Acoustical Society of America*, 1970, 48(4, Pt. 1), 843-853.

The first phase of a research program designed to quantify subjective responses to time-varying sounds grossly approximating those produced by aircraft flying over an *O* at rest are described. The basic sounds employed represented "approaching" and "receding" sources that continuously increased or decreased in intensity and/or frequency over a period of 15.25 sec. The comparative annoyance or noisiness of such sounds was evaluated by means of paired comparison and individual adjustment judgments. For the 3 experiments conducted with 72 16-27 year old undergraduates and high school students, the findings indicate that (a) Signals representing an approaching sound were generally judged more annoying than those representing a receding sound in spite of the fact that the approaching and receding signals contained the same average intensity and frequency content over signal duration. (b) Sognals with time-varying components whether intensity or frequency were judged to be noisier than signals with non-time-varying components. (c) Time-varying intensity components appeared to have a greater influence on judgements of noisiness than did time-varying frequency components. And (d) on the average, only small non-systematic differences in noisiness were found as a function of the 3 frequency conditions investigated (125-, 1000-, and 4000-Hz-band center frequency).

Sanders, Jay W. & Josey, Anne F. Narrow-band noise audiometry for hard-to test patients. Journal of Speech & Hearing Research, 1970, 13(1), 74-81.

The applicability, validity, and reliability of narrow bands of white noise was investigated as test stimuli for obtaining audiograms under earphones with 10 normal-hearing adults, 10 hearing-impaired children, and 10 mentally retarded children. Test results for the hearing-impaired and mentally retarded Ss suggest that validity and reliability were better for noise-band audiometry than for pure-tone assessment in Ss. Results with the mentally retarded suggest that the task of attending to narrow-band noise stimuli was easier than the pure-tone listening task. The noise-band procedure retains the advantages of pure tone audiometry in that it (a) can be used as a means of monaural assessment of hearing sensitivity by frequency, and (b) tests functional hearing rather than peripheral sensitivity.

Schneider, Bruce A., Neuringer, Allen J. & Ramsey, Douglas. Magnitude estimation of loudness with a minimum 24-h interstimulus interval. *Psychonomic Science,* 1972, 27(4), 243-245.

Twenty four high school students made magnitude estimates of the loudness of white noise in each of 2 conditions: when the time between consecutive stimulus presentations was at least 24 hr., and when it was less than 2 min. In both conditions, the relationship between the reports of Ss and intensities of the stimuli was best described by a power function. The exponent of the function was lower and the variance slightly greater in the 24-hr. interstimulus condition.

Selery, Frank L. & Streczyn, Micheal. Noise characteristics in the baby compartment of incubators. *American Journal of Diseases in Children,* 1969, 117(4), 445-50.

An analysis of noise in 17 baby incubators and their surrounding environments indicated high levels, well above the recommended acceptance level.

A study of the magnitude of transportation noise generation and potential abatement. Volume II. Measurement criterion. *Serendipity Inc Arlington Va Eastern Operations Div.,* 1970, 119 p.

Evaluations of the effectiveness of transportation noise abatement require the use of a measure which relates individual and community reactions to transportation noise. Previous studies were examined to determine how well various measures predicted response to noise. A-weighted sound level (in dBA) and noise pollution level (in dBA) were examined to determine their relationships to other measures and their prediction of reaction, i.e., loudness, annoyance, noisines . The A-weighted sound level, on the average, correlated as well with subjective response as the other measure. Only for jet aircraft pure tones was there a significant predictive performance difference between effective perceived noise level (EPNL) and dBA, favoring EPNL.

Average community response measures were developed for aircraft and motor vehicle noise. Using the aircraft noise and number index and motor vehicle traffic noise index data, the noise pollution level was shown to correlate as well with average community response as both of the measures. Since noise pollution level is compatible with the use of dBA for individual vehicles, its selection as a community measure complements the choice of dBA as a vehicle measure.

Sidorova, A. V. On the character of noise in day nursery groups. Pediatriya, 1970, 49(1), 67-70.

This research attempted to determine the factors affecting the noise level in the day nursery, and the noise level in the day nursery for children of different ages and at different intervals of time. There is no doubt that degree of exitation in children and their behavior are a direct function of noise level in the group.

Stevens, S. S. Perceived level of noise by Mark VII and decibels (E). Journal of the Acoustical Society of America, 1972, 51(2, Pt. 2), 575-601.

The calculation procedure, Mark VII, which gives the perceived level (PL) of loudness or noisiness in dB (PLdB) is described. It utilizes a set of frequency-weighting contours based on an average of 25 experimental contours. The standard reference sound is defined as a 1/3 band centered at 3,150 Hz. The perceived magnitude (loudness or noisiness) grows as the 2/3 power of the sound pressure, so that perceived magnitude doubles with each increase of 9 dB. The summation formula for the total subjective magnitude remains St=F(SIGMAS - Sm), but the value of F is made to vary as a function of level to reflect the nonlinear growth (in log-log coordinates) of broad-band noise. As a result of the new reference sound at 3,150 Hz., PLdB is approximately 8 dB. lower than the older loudness level in phons. Except for the nearly constant difference of 8 dB., Mark VI and Mark VII give closely similar results for typical broad-band noises. The 8-dB downward shift makes it possible for a sound level meter with an "ear weighting" to give readings within 1-2 dB. of perceived level in PLdB. With the frequency-weighting contours-weighting contours-extended down to 1 Hz., Mark VII also provides a procedure for calculating the PLdB of sonic booms and other impulse noises.

Sullivan, Richard, Warren, Richard & Dabice, Margaret. Minimal aversion thresholds for white noise: Adaptation. _American Journal of Psychology_, 1970, 83(4), 613-620.

Noises of four different amplitude were presented to 20 undergraduates, who then judged minimal aversion thresholds for a white noise presented binaurally in ascending and descending series. Both adaptation and series influenced their judgments, but the differences in judgments were greater between series types than across adaptation levels. Findings suggest that thresholds for the attribute of aversive loudness can be effectively specified. The possibility of a psychological scale of aversiveness common to all sensory systems is discussed.

Tobias, Jerry V. Noise audiometry. _FAA Office of Aviation Medicine Report_, 1971, 71-1, 5 p.

An audiometric device is described which uses a narrow band of noise as a test signal and an efficient procedure that yields masking patterns.

Wood, Thomas J. An application of digital computer logic to pure-tone audiometric procedures. (Doctoral dissertation, University of Southern Mississippi) Ann Arbor, Mich.: University Microfilms, 1970, No.71-13, 593, 174 pages.

Specifically, this study involved programming approximately 10,000 individual computer instructions. These instructions provided the logic by which a PDP-8/I computer was programmed to administer stimuli and analyze responses associated with pure-tone audiometric procedures. A second purpose of this study was to develop and refine innovative methods of coupling or interfacing the computer with audiometric testing equipment. By interfacing the computer by means of an AX08 Laboratory Peripheral Unit and related circuitry, it was possible to achieve computer patient interaction. Interaction involved indirect communication between the computer and the patient as a function of input and output signals fed to and from the AX08 unit.

In order to test the relative accuracy of computer-determined thresholds based on binary logic, it was necessary to audiometrically test the hearing sensitivity of a number of patients employing computer controlled audiometric procedures, and compare and contrast the obtained results with thresholds obtained by means of conventional-manual audiometry. Sixteen subjects were selected from patients attending the University of Southern Mississippi Speech and Hearing Clinic. Each of the sixteen patients was randomly assigned to an A1-A2 comparison condition and were subsequently tested by two audiologists. The eight patients within Group 2 participated in an A1-C comparison and were audiometrically evaluated by one of the above audiologists and a PDP-8/I computer As a result of the preceding experimental design, it was possible to compare paired correlations obtained between the audiologists (A1-A2 comparisons) and between one of the audiologists and the computer (A1-C comparisons). Correlational data involved paired observations between masked and unmasked thresholds as well as effective masking levels employed in the determinations of masked thresholds. Correlations obtained in the above manner provided a means of conducting a concurrent validity type of study in which conventional manual audiometry provided a generally accepted method for testing hearing.

In general the obtained data indicated high correlations between both A1-A2 and A1-C comparisons. The results of this study indicate that, among the subjects tested, computer-determined thresholds based on binary-computer logic correlate quite well with thresholds obtained by means of conventional-manual-audiometric procedures.

Zwislocki, J. J. Temporal summation of loudness: An analysis. *Journal of the Acoustical Society of America,* 1969, 46(2, Pt 2) 431-441.

A quantitative psychophysiological theory for loudness level and loudness as a function of stimulus duration was developed. It is based on the psychophysical and neurophysiological evidence that the apparent temporal summation of acoustic energy is a result of neural summation at a high level of the auditory system. The theory shows how this can be achieved in spite of a nonlinear relationship between sound intensity and neural excitation. The temporal decay of neural firing preceding the final stage of temporal summation seems to be responsible for overcoming the nonlinearity.

DEVELOPMENT ASPECTS OF NOISE RESPONSES AND INDIVIDUAL AND CLASS DIFFERENCES

In this area, age differences, class differences and the effects of auditory stimulation on the newborn have been investigated. For example Mendel (1971) found that four to eleven month old infants responded more frequently to broadband than to narrow band noise. Ling (1923) showed that the proportion of whole body responses increased as a function of the duration of narrow band noise and that pulsed trains of 50 msec. pulses proved to be less effective in eliciting the responses than did continuous noise. Bench (1969) has produced evidence that crying babies "quiet" more readily when exposed to auditory stimulation than when unstimulated.

Smith (1969), Jeffrey (1969) and Smith and Prather (1971) have investigated age differences in responses to varying noise environments. With respect to consonant identification, phoneme discrimination and serial reaction time, subjects older than 60 years performed significantly more poorly in identifying consonants in both a noise and no noise environment; performed more poorly on phoneme discrimination tasks than younger subjects (less than 30 years old); but showed no differences in reaction time. Social class differences have been investigated by Anderson (1972). Her results indicate that middle class second graders do more poorly in a white noise and "home noise" environment than in quiet while lower class children did equally well in the noise environments in the Porteus Maze task, word completion and counting. This suggests that lower class children growing up in a noisy environment may develop some mechanism for "tuning out" environmental noise.

Anderson, Patricia Ann Skildum. Social class, noise, and performance. (Doctoral dissertation, Claremont Graduate School) Ann Arbor, Mich.: University Microfilms, 1972, No. 72-30, 554, 77 pages.

This study was concerned with the development and social class differences during three types of noise.

Three classes each of second and sixth graders from a school in a suburban area of Washington state were tested on three kinds of performance items (Porteus Mazes, word completion, and counting) while listening through earphones to two four minute periods each of silence, white noise, and home noise. All children were white and without identified hearing problems. Sixty-one second graders and fifty-eight sixth graders were identified by socioeconomic status and served as subjects for the experiment.

Results of the testing indicated significant differences on the noise and noise by social class interaction variables for second graders. Middle class second graders do more poorly in the white noise and home noise condition then in the silence condition. Lower class children do equally well in each of the three conditions.

Analysis of the sixth grade results indicated no significant differences although graphically the middle class sixth graders did equally well in the silence and white noise condition and better under the home noise condition. Lower class children did equally well in each of the three conditions.

A Chi^2 comparison between middle class second and sixth graders was significant indicating that second graders do worse during the home noise condition than in the silence condition and sixth graders do better during the home noise condition than during the silence condition. A Chi^2 with lower class second and sixth graders was not significant, suggesting no development differences.

Bench, John. Some effects of audio-frequency stimulation on the crying baby. Journal of Auditory Research, 1969, 9(2), 122-8.

Two experiments are described in which crying babies were stimulated by pure tones and noise bands of one minute duration. The babies generally quieted more readily when exposed to auditory stimulation than when unstimulated. The effectiveness of the sound stimulus was in inverse relation to frequency. Differential masking effects, tactile artifact, and an innate pitch discrimination or preference are considered as explanatory hypotheses.

Brown, Cheryl & Jackson, Donald E. The effects of high-intensity noise in early development upon behavior in the adult rat. *Proceedings of the Annual Convention of the American Psychological Association*, 1971, 6(Pt.1), 207-208.

Following 30 days (age 26-56 days) of either high intensity noise exposure or control conditions, 38 rats were subsequently either trained in a U maze or tested in an open field. Analysis of variance revealed significant Noise and Noise x Sex interaction effects on U maze performance. No differences in the open field test were observed. These results suggest a differential sex effect of noise on subsequent learning where emotional factors have been controlled.

Imes, Shirley A. & Etaugh, Claire F. Emotionality in mice as a function of infantile stimulation. *Psychonomic Science*, 1971, 22(1), 19-20.

Assigned 2 litters of inbred C57Bl/10J mice ($N = 74$) to each of 6 groups consisting of 3 early experience and 2 later testing conditions. Early experience consisted of handling, auditory stimulation (buzzer), or neither. At 25-27 and 35-37 days, defecation and motility in both an open field and an enclosed runway were measured, with the buzzer present during testing for 37 *S*s. The handled *S*s were more emotional than the other early-experience groups, as shown by more defecation in the open field and less motility in the runway with the buzzer present.

Jeffrey, Dwight W. Age differences in serial reaction time as a function of stimulus complexity under conditions of noise and muscular tension. (Doctoral dissertation, University of Southern California) Ann Arbor, Mich.: University Microfilms, 1969, No. 70-8527.

The objective of this study was to examine serial reaction times in the light of the neural noise hypothesis and activation hypothesis of the aging central nervous system.

According to the neural noise hypothesis, slowing of response speed with age is due to an increasing level of internal random "noise" in the brain, which tends to reduce the signal-to-noise ratio of the sensory input. This increased neural noise makes it more difficult for the brain to distinguish a signal from the background and consequently the older individual must accumulate data over a longer period of time. This sampling time becomes longer as the ratio of signal strength to background noise becomes smaller. It is postulated that conditions which would lower the signal-to-noise ratio would tend to result in the slowing of behavior. Exposure to added sensory stimulation, such as auditory white noise or induced muscular tension, is postulated to result in an increased level of background noise, a lower signal-to-noise ratio, and slower response speed.

The activation hypothesis would predict the opposite result. The activation hypothesis assumes that because of loss of functional neural cells with age or a reduction in the overall level of stimulation, the central nervous system in the older individual is at a lower level of activation than in the younger individual. The older nervous system, being less activated and less sensitive to any input, must integrate data over longer intervals of time and thus the older individual's responses become slower. It is postulated that the older, less activated, central nervous system, when presented with added sensory stimulation such as auditory white noise or induced muscular tension, would have the level of activation raised and that consequently the response times would become faster.

Serial reaction times were recorded using the PSYCHOMETER apparatus for five levels of task complexity under sensory conditions of induced muscular tension (20 per cent of maximum hand grip), auditory white noise (75 decibels), and a control condition without noise or tension. Thirty young (18 to 26 years) and 30 elderly (62 to 85 years) subjects, selected to be free from chronic illness or sensory disabilities participated in the study. All subjects were exposed to all conditions in a balanced design. Mean serial reaction times for the two age groups differed as expected, in that the elderly subjects responded more slowly than the young subjects at all levels of task complexity. Age differences ranged from .12 seconds for the simplest task to .32 seconds for the most complex task. Reaction time was found to increase linearly with task complexity, as measured. A significant interaction between age and task complexity was found. This consisted of two components. At the simplest level of complexity, elderly subjects appeared to be at a lower limit of responding and there was less of an effect of differences in complexity than was the case for the younger subjects. In the more complex tasks, elderly subjects slowed to a greater extent as the level of complexity was increased than did young subjects. Examination of serial reaction times in the three sensory conditions for both age groups indicated no different effect due to white noise or induced muscular tension as compared with the control condition. However, an order of presentation effect was found indicating that the subjects tested first under the conditions of noise and tension had shorter response times under the first condition as well as under subsequent conditions, than those subjects who were tested first under the control conditions. These interaction effects on reaction time were greater for the elderly than for the young subjects, and are interpreted as supporting the activation hypothesis. However, the overall mean response latencies for the three conditions were not different and did not support the activation theory.

The lack of differences in reaction time under the three conditions, and the interaction between conditions and order of presentation appear to offer contradictory evidence for the activation hypothesis.

Mansfield, Richard Scott Developmental trends in the effects of noise on problem solving. (Doctoral dissertation, Harvard University) Ann Arbor, Mich.: University Microfilms, 1971, No. 71-13,283.

Earlier research has shown that there is a development with age in the ability to attend selectively. Selective attention may be viewed as coping with irrelevant stimulus variation or noise, during problem solving.

The purpose of the present study was to test for the development of the ability to cope with noise in problem solving. Two tasks: an auditory task and a visual task, were used to test the ability. As a test of general intelligence, the Peabody Picture Vocabulary Test was also administered. There were 30 kindergarten and 30 second grade subjects: 15 boys and 15 girls at each grade level.

The visual task tested the ability to cope with visual noise in three types of problems: the first a discrimination with constant position of presentations of cues, the second a discrimination with varying position of presentation of cues, and the third a relational problem. In all problems the positive and negative cues appeared on the right and left sides of a movie screen. Both types of discrimination problems required the subject to point to a constant pair of shapes, and the relational problems required the subject to point to larger, thinner, or flatter pairs of shapes. On all problems the subject first learned to point correctly in the absence of noise. Visual noise, irrelevant shapes superimposed over the cues, was then added in graduated increments on successive trials, until the subject made an error.

The auditory task tested a subject's ability to detect a target message through different intensities of noise. The task required the subject repeatedly to point to one of eight familiar objects drawn on a sheet of paper in the absence of noise. The noise, a mixture of four voices talking together, was then superimposed over the signal in graduated increments in successive trials, until the subject made an error. Next, the noise level was set high enough to preclude perception of the signal, and then lowered in graduated increments, until the subject pointed correctly. The procedure was repeated five times at each of three levels of signal volume.

For the visual task the results showed that thresholds for noise were a function of the type of problem. Kindergarteners had their highest thresholds on the discrimination with varying position. Thresholds were slightly lower on the discriminations with varying position. The lowest thresholds were on the relational problems. Second graders performed at maximal levels on both types of discrimination problems, but at significantly lower levels on the relational problems. The second graders were consistently superior to the kindergarteners. At each grade level subjects with higher IQs performed better than subjects with lower IQs. However at the kindergarten level the superiority of the high IQ group was more marked on the discriminations than on the relational problems, while at the second grade level the superiority of the high-IQ group was apparent on the relational problems, but not on the discriminations.

Ling, Daniel. Acoustic stimulus duration in relation to behavioral responses of newborn infants. *Journal of Speech and Hearing Research*, 1973, 15(3), 567-571.

The responses of 160 1-4 day old infants to short duration (50-1000 msec.) narrow-band noise stimuli were studied. The proportion of responses obtained, particularly of the whole-body type increased as a function of duration. Interrupted stimuli (trains of 10 50 msec. pulses) proved to be much less effective than continuous stimuli of the same duration.

Mendel, Maurice I. Infant responses to recorded sounds. *Journal of Speech and Hearing Research*, 1971, 11(4), 811-16.

Thirty, 4-11 month old infants were tested with five different recorded sounds that varied in bandwidth and temporal configuration: a continuous band of white noise, the same band of noise interrupted twice/sec, the crinkling of onionskin paper, a narrow band of noise centered at 3000 Hz, and a warbled 3000 Hz tone. With loudness and duration of the stimuli held constant, more responses occurred to sounds composed of a broad-band spectrum than to those of a limited bandwidth. Temporal configuration of the sound had no effect on the number of responses elicited.

Smith Raymond Akert. A study of phoneme discrimination in older versus younger subjects as a function of various listening conditions. (Doctoral dissertation, University of Washington) Ann Arbor, Mich.: University Microfilms, 1969, No. 69-18,316.

A review of the research literature dealing with the effect of aging on the nervous system reveals at least two assumptions that have been made by various authors: (1) with advancing age there is a lowering of resistance to interference with signal transmission in the nervous system, and (2) with advancing age there are fewer functional cells, contributing to reduced "channel capacity" in the nervous system.

These assumptions are of particular interest in the consideration of speech discrimination problems commonly found in the aging person.

To attempt to learn more about the functioning of the central auditory neural system, with these assumptions as a basis, the present study was designed to (1) investigate systematically the effects of aging on speech discrimination as a function of varying levels of signal (speech) presentations and levels of background noise, (2) determine and evaluate quantitatively and qualitatively the phoneme errors and confusions made by a subject group of older individuals whose hearing losses are judged to be primarily due to the aging process and not to other etiologies, and (3) to compare the results to those obtained from a group of younger individuals with normal hearing.

To investigate these above items the following hypotheses were formulated:

1. As a group, older individuals 60 years of age or more, and having essentially normal hearing for pure tones through the speech frequency range, will perform significantly poorer on speech discrimination tasks than will younger, normal hearing individuals, 18 to 30 years of age.

2. That the between-the-group differences will become progressively greater as the sensation level of noise is increased for any given signal to-noise relationship.

3. That the between-the-group differences will become progressively greater as the signal-to-noise relationship is decreased for any given level of noise.

Two groups of subjects were selected, both of which met certain maximum criteria for "normal" hearing. The experimental group consisted of individuals 60 years of age and older, the control group 18 to 30 years. Both groups were required to listen to thirty tasks of sixteen CV nonsense syllables presented monotically under conditions of varying SL's of noise and S/N relationships and write their responses as to what they heard. From the subject responses error response scores were derived and confusion matrices were compiled. The data were then analyzed and discussed both quantitatively and qualitatively.

The results of the analysis supported the first test hypothesis but not the second and third hypotheses.

The following were concluded:

1. Under the conditions of this study older subjects, as a group, performed more poorly on the discrimination tasks than did younger subjects as a group.

2. The presumption that the CNS (including the central auditory system) experiences an increasingly poorer resistance to exogenous noise interference was not demonstrated or supported.

3. There are qualitative as well as quantitative differences in the performance of the "old" versus the "young" on auditory discrimination tasks of CV nonsense syllables presented under varying conditions of noise.

Smith, Raymond A. & Prather, William F. Phoneme discrimination in older persons under varying signal-to-noise conditions. *Journal of Speech & Hearing Research,* 1971, 14(3), 630-638.

Two groups of *Ss*, 10 older than 60 yr. of age and 10 18-30 yr. olds, having essentially normal hearing for pure tones at the speech frequencies identified 16 consonants in a CV context. These syllables were presented at 6 sensation levels (SL) of noise over 4 signal-to-noise (S/N) ratios. An analysis of variance of the mean percent correct responses showed that the older group performed significantly more poorly than the younger group over all listening conditions. There was no difference in the relative performance between the 2 groups as either the SL of noise was increased or the S/N ratio became poorer. An additional listening condition in which no noise was present in the signal and the syllables were presented at 6 SLs revealed results similar to the main expcriment.

PERSONALITY VARIABLES

Most recent studies of noise and personality have focused on introversion or extraversion as contributors to psychomotor performance differences under noise conditions. These studies have been generated by Eysenck's theory of personality and cortical arousal. In general, extroverts were found to display greater decrements in psychomotor performance while experiencing noise stimulation than were introverts. Di Scipio (1971) showed that white noise facilitates psychomotor response for an optimal period of time, after which decrements were observed. This effect was heightened for extroverts . Even though extroverts are more prone to noise distraction Elliott (1971) showed that they will tolerate greater intensities of white noise than will introverts. In the same study, sex differences were found in noise tolerence, with boys tolerating higher intensities. No age differences were observed between 5- and 10- year olds. In several studies, physiological measures tended to corroborate the prediction that extroverts experience greater arousal in the presence of the noise stimulus than do introverts.

Other studies on noise and personality are diverse. Edsell (1973), discovered that Ss in a game situation perceived other players as more disagreeable, disorganized, and threatening under noise as apposed to no-noise conditions. Jansen & Hoffman (1971) demonstrated that increasing loudness of a noise stimulus augmented subjective annoyance, with neurotic personality tendencies contributing to this effect. Angrier speakers were found to use more high frequency elements in their speech in a study by Mason (1969). Stephens (1970) showed that test anxiety scores correlated positively with the slope of a loudness judgement function.

Other research was ambivalent in trying to relate noise to psychiatric morbidity.

Colby, Kenneth Andrew. Effects of white noise intensity and changes in intensity on the reaction time of schizophrenics and non-psychiatric patients. (Doctoral dissertation, University of Iowa) Ann Arbor, Mich.: University Microfilms, 1971, No. 71-30418.

To test the differential predictions of an under-arousal hypothesis and an attention hypothesis of schizophrenic deficit, 36 process schizophrenics, 36 reactive schizophrenics and 36 non-psychiatric medical and surgical patients performed 48 disjunctive reaction time trials under each of four conditions of white noise presentation: 1) constant high intensity, 2) constant moderate intensity, 3) change from moderate to high intensity one second before onset of the reaction time signal, 4) change from moderate to low intensity one second before onset of the reaction time signal. The under-arousal hypothesis predicted that the noise conditions with high intensity would differentially facilitate performance of schizophrenics, while the attention hypothesis predicted that the conditions which change in intensity would differentially facilitate performance of schizophrenics. None of the noise manipulations differentially facilitated performance of schizophrenics. The results were interpreted as supporting neither the under arousal nor the attention hypotheses.

Di Scipio, W.J. Psychomotor performance as a function of white noise and personality variables. Perceptual and Motor Skills, 1971, 33(1), 82.

The psychomotor performance of 14 Ss selected for extreme extraversion and introversion scores on the Eysenck Personality Inventory (Form A) was studied under white noise and silence conditions. White noise facilitated massed psychomotor performance for an optimal period of time, after which noise became a distracting or aversive stimulus. As expected from H. Eysenck's theory of personality and cortical arousal, the extroverts were significantly more susceptible to this effect than the introverts.

Edsell, Richard D. The effect of noise on some interrelationships between social interaction and anxiety. Dissertation Abstracts International, 1973, 33(8-B), 3976.

The primary purpose of this study was to investigate the effects of noise on some interrelationships between social interaction and anxiety. Three independent groups of subjects participated in the simulation game *Starpower* while they were exposed to different levels of environmental noise: Quiet, Very Noisy. To assess the change in anxiety resulting from the increased noise, the following measures were employed as operational definitions of anxiety: (1) STAI anxiety inventory, (2) eye blink rate, (3) Digit Symbol test, and (4) Self-Evaluation of Group Behavior scale.

The results indicate that relatively low levels of noise induced anxiety in subjects engaged in social interaction. STAI and Group Behavior scale scores demonstrated significant increases with increasing noise. Subjects who played *Starpower* under noisier conditions perceived other players as more disagreeable, disorganized, and threatening.

Digit Symbol data showed a definite tendency for scores to improve with louder noise. Apparently the subjects adapted successfully to the accumulative stress effects by increasing their effort to prevent decremental performance. Eye blink was not significantly affected by the experiment, suggesting that the threshold of sensitivity of the eyeblink mechanism is too high for the stress levels induced. The four measures were found to be largely uncorrelated, thus supporting the hypothesis that the manifestations of anxiety are multi-dimensional.

Elliott, Colin D. Noise tolerance and extraversion in children. *British Journal of Psychology*, 1971, 62(3), 375-380.

A method of measuring tolerance of white noise is described. Thirty-two 8-yr-olds and 32, 10-yr-olds were rated for extroversion and tested for noise tolerance. Extroverts tolerated a significantly greater intensity than introverts. Boys tolerated a significantly greater intensity than girls. There was no difference between the 2 age groups in level of noise tolerance. It is concluded that the method can be used to measure extroversion in a younger age range than is possible with questionnaires.

Results are discussed in terms of Eysenck's concepts of stimulus hunger, stimulus avoidance, and hedonic tone.

Epstein, Seymour & Fenz, Walter D. Habituation to a loud sound as a function of manifest anxiety. *Journal of Abnormal Psychology*, 1970, 75(2), 189-194.

Forty undergraduates were subdivided on each of several scales of a specially devised test of manifest anxiety. They were presented with 10 trials of a 115-dB noise. GSR and basal skin conductance were monitored continuously. The habituation curve of the GSR was a typical negatively decelerated habituation curve. The habituation curve of basal conductance rose in the first few trials and then gradually declined, resembling a giant GSR. While there were no differences in curve form for *S*s divided on the total scale, differences emerged when *S*s were divided on subscales of Striated Muscle Tension and Autonomic Arousal.

Fisher, S. Boundary effects of persistent inputs and messages. *Journal of Abnormal Psychology*, 1971, 77(3), 290-5.

The effects of intense white noise, hostile messages, dependency messages, depressive messages, and optimistic-reassuring messages on the body image boundaries of 87 male and 86 female undergraduates were evaluated. *S*s completed the first 25 blots of the Holtzman Inkblot Technique Series under ordinary conditions and Series A under sensory input. Results indicate that only hostile messages produced boundary decrement and this effect was supported in a cross-validation study. Reasons why hostility should have a greater boundary-disturbing impact on males than on females are discussed.

Gattoni, F. & Tarnopolsky, A., Aircraft noise and psychiatric morbidity. *Psychological Medicine*.1973,3(4), 516-520.

This research replicated a 1969 investigation which showed that admission rates to a pschiatric hospital were higher from higher noise zones close to Heathrow Airport than from relatively quieter areas. Data do not confirm those results, although a trend in agreement with the original findings was found. The scope of the relationship between levels of aircraft noise and types of psychiatric morbidity is discussed.

Gulian, Edith. Focusing of attention and arousal level under interaction of stressors in introverts and extroverts. *Revue Roumaine des Sciences Sociales-Serie de Psychologie*, 1972, 16(2), 153-167.

This research tested the hypothesis that two stressors, noise and intermittent light, would impair reaction time (RT) performance in extroverts more than introverts and that the effects of personality predisposition would be constant across attention tasks. Twenty *Ss* equally divided between introverts and extroverts based on Eysenck personality inventory scores were exposed to noise and light stressors while responding to a serial choice RT task, and J.R. Stroop color-word interference task, and Pieron's grometric figure selection task. Introverts made fewer errors on the RT task. In general, extroverts showed a higher arousal level and poorer performance while introverts performed the tasks better but their arousal level was lower and decreased throughout the experiment.

Gulian, Edith. Psychophysiological (autonomic) correlates of auditory vigilance under noise conditions. *Revista de Psychologie*, 1972, 18(1), 41-51.

A comparison of the mean heart rate (HR) values of 20 *Ss* showud that, under weak continuous noise (70db), there were only slight changes in HR, whereas anticipation of loud intermittent noise (90db) induced HR acceleration. Changes in HR variability depended on personality type (introversion-extroversion) and the stimuli sequence. It is concluded that HR acceleration is a component of the orientation reaction.

Jansen, G. & Hoffman, H. Noise-induced changes in fine motoricity and noise-induced feelings of annoyance which depend upon definite personality dimensions. *Army Foreign Science and Technology Center Charlottesville Va.*, 1971, Report No. FSTC-HT-23-236-71.

Judging noise situations by means of adjective scales it was proved that increasing loudness caused an augmentation of annoyance. The concept of annoyance consists of three dimensions: emotional factor, activity and tension. Certain dimensions of personality (neuroticism) augment the negative judging of noise.

Janssen, R.H. & Topman, R.M. Differentiation between endogenous and neurotic depression. Nederlands Tijdschrift voor de Psychologie en haar Grensgebieden, 1971, 26(7), 454-475.

A study with 9 endogenous-depressive, 10 neurotic-depressive and 11 schizophrenic women under medication is described. Ss mean CA ranged from 41-47 yr. 4 hypotheses were tested that the basal GSR would be the highest with the most depressed group; (b) the amplitude of the psychogalvanic response (PGR) would be about equal among the groups; (c) the process of becoming accustomed to noise-stimuli, as measured by the PGR, would be more evident among neurotic-depressive Ss than other groups; and (d) that the GSR would be higher among extroverts than introverts. Experimental techniques measured the GSRs, PGRs, plethymograms, Rts, and responses on several adjustment questionnaires, e.g., the Amsterdam Biographical Questionnaire. The 1st, 2nd, and 4th hypotheses were confirmed. The 1st and the 4th were found to be significant at the .05 and .01 levels.

Mason, R.K. The influence of noise on emotional states. Journal of Psychosomatic Research, 1969, 13(3), 275-282.

In order to discover what significance could be attached to the presence of high frequency sound in human conversation, this element of voice pattern was studied by recording asthmatic and control families asked to say certain words of emotive and nonemotive content on a 3rd octave band analyzer. Only words with emotive meanings yielded differences between the parents of the 2 groups: it seems that adults modulate the ultrasonic content of their voices according to the emotional meaning of the words. Further, the angrier the speaker, the more high frequency elements were found. It appeared also that the endpoints of hearing of asthmatics were higher than those of the controls, which makes them more sensitive to high frequency sounds. The action of asthmatic breathing which is of high pitch is discussed.

Mohan, Jitendra & Munjal, Nalini. Neuroticism extraversion as determiner of effect of distraction on psychomotor performance. Psychologia: An International Journal of Psychology in the Orient, 1972, 15(1), 49.

An experiment was planned to analyze the effect of auditory distraction on simple "psychomotoor performance. The study was aimed at "qualifying" the relationships among personality, performance, and distraction. The general theoretical background was based on Eysenck's arousal theory, Broadbent's filter theory of distraction, and Wilkinson's theory of environmental stressors. 120 Ss were students selected from a group of 500 on the basis of their score on the Junior Personality Inventory. Distraction was provided by an electric bell timed by a stop watch. It is concluded that the distracting effect of noise depends on its intensity and quality as well as on task difficulty.

Stephens, S.D. Personality and the slope of loudness function. Quarterly Journal of Experimental Psychology, 1970, 22(1), 9-13.

The slope of the loudness function in direct magnitude estimation at two frequencies was studied in two groups of naive Ss. In Group I a limited scale was used and in Group II, and open-ended scale. In all conditions the slope of the loudness function was found to be significantly positivly correlated with test anxiety scores.

Sullivan, Richard. Subjective matching of anxiety to intensities of white noise. Journal of Abnormal Psychology, 1969, 74(6), 646-50.

Twenty undergraduates (a) matched intensities of white noise to levels of experienced anxiety under stress and nonstress conditions, (b) judged a minimal aversion threshold of white noise, and (c) rated a level of anxiety which matched the aversiveness of the noise. Anxiety and noise matchings indicated relatively lawful agreement during stress and nonstress conditions. It was found that at only one point during the stress condition did the anxiety and noise judgements exceed the mean subjective aversion level. Findings suggest that changes in the intensity of internal states may be measured through the use of judged matchings with changes in intensive sensory stimuli.

SOCIALLY RELEVANT BEHAVIOR

Evidence in this area seems to indicate that noise has the potential for influencing a wide range of socially relevent behaviors. For example, Bull, (1973) has shown that tolerance for ambiguity decreases in a noise environment of 84 dB. Also, Edsell (1973) produces evidence which indicates that even "low" noise levels induce anxiety in social situations and that perception of others assumes negative dimensions, such as disagreenable, disorganized, and threatening. Glass (1974) has shown both frustration tolerance and task performance decrease following stimulation with unpredictable noise and that the after effects are more marked for unpredictable noise, although the organism physiologically adapts, there is a "psychological" cost of exposure to the noise environment.

Bull, Andres, J. et al. Affects of noise and intolerance of ambiguity upon attraction for similar and dissimilar others. Journal of Social Psychology, 1973, 88(1), 151-152.

Noise as a mild stressor was used in an experiment which followed the procedure of W. Griffith and K. Veitch (see PA,Vol 45: 9845). Eight like-sexed groups of 8 volunteers (a) completed an attitude questionnaire; (b) were exposed to background noise levels of 84 or 40 db. (control condition) while completing the Intolerance of Ambiguity scale the Nowlis Adjective Check List of Mood, and multiplication and anagram Tasks; and (c) used the interpersonal judgement scale to rate the S sitting opposite the 2 hypothetical others with attitudes similar or dissimilar to their own. Although noise did not influence attraction, differences in similarity of attitudes and the interaction of noise, sex, and similarity had significant effects. As predicted, controls who were tolerant of ambiguity were more influenced by the similarity dissimilarity of other than controls who were tolerant. However, in the noise condition tolerant Ss showed a significant increase in responsiveness to similarity and were indistinguishable from intolerant Ss.

Cameron, Paul; Robertson, Donald; Zeks, Jeffry. Sound pollution, noise pollution, and health: Community parameters. *Journal of Applied Psychology*, 1972, 56(1), 67-74.

A random sample of 2,130 Detroit, Michigan and 496 Los Angeles, California families were interviewed by telephone to explore urban parameters of noise and sound pollution. An adult member of the family reported the health status and sound-noise exposure of all family members. Results suggest (A) a possible association between sound exposure and increased prevalence of both acute and chronic illness; (B) the exposure of males to noise more frequently than females; (C) the interpretation of machine, plane, and traffic sounds as noise and musical and children's sounds; (D) the interpretation of sounds at work as noise and sounds at home as sound; and (E) the regular annoyance by sounds of approximately 1/4 of the women and 1/3 of the men in our society.

Edsell, Richard Dean. The effect of noise on some interrelationships between social interaction and anxiety. (Doctoral dissertation, Drexel University) Ann Arbor, Mich.: University Microfilms, 1973, No. 73-4040.

The primary purpose of this study was to investigate the effects of noise on some interrelationships between social interaction and anxiety. Three independent groups of subjects participated in the simulation game Starpower while they were exposed to different levels of environment noise: Quiet, Very Noisy. To assess the change in anxiety resulting from the increased noise, the following measures were employed as operational definitions of anxiety: (1) STAI anxiety inventory, (2) eye blink rate, (3) Digit Symbol test, and (4) Self-Evaluation of Group Behavior scale.

The results indicate that relatively low levels of noise induced anxiety in subjects engaged in social interaction. STAI and Group Behavior scale scores demonstrated significant increases with increasing noise. Subjects who played *Starpower* under noisier conditions perceived as more disagreeable, disorganized, and threatening.

Digital Symbol data showed a definite tendency for scores to improve with louder noise. Apparently the subjects adapted successively to the accumulative stress effects by increasing their effort to prevent decremental performance. Eye blink was not significantly affected by the experiment, suggesting that the threshold of sensitivity of the eye-blink mechanism is too high for the stress levels induced. The four measures were found to be largely uncorrelated, thus supporting the hypothesis that the manifestations of anxiety are multidimensional.

Glass, D.C., Reim, B., & Singer, J.E. Behavioral consequences of adaptation to controllable and uncontrollable noise. *Journal of Experimental Social Psychology*, 1971, 7, 244-57.

The behavioral consequences of adaptation to high-intensity periodic noise were investigated under conditions where *S*s believed or did not believe they had indirect control over termination of the noise. Findings with 47 undergraduate males show that the work of adapting to uncontrollable, in contrast to controllable, noise resulted in heightened overall tension (tonic skin conductance), and impaired performance efficiency after termination of all the noise. Several theoretical explanations of these results are discussed, including interruption-based helplessness. The relationship of the present experiment to previous noise research is considered.

Glass, David C.,& Singer, Jerome E. Experimental Studies of uncontrollable and predictable noise. *Representative Research in Social Psychology*,1973, 4(1),165-183.

A series of laboratory and field experiments were conducted with more than 200 *S*s to study behavioral effects and aftereffects of exposure to unpredictable and uncontrollable high-intensity noise. *S*s tolerance for frustration and quality of task performance were impaired following stimulation by unpredictable noise. Even though physiological adaptation occurred to an equivalent degree under predictable and unpredictable noise, adverse aftereffects were greater following exposure to the latter type of noise. Subsequent experimentation suggested that unpredictable noise has these effects because the individual believes he cannot determine onset and/or offset of the stressor. When perception of control over unpredictable noise was manipulated, frustration tolerance and post-noise task performance were appreciably improved. It is concluded that psychological factors, not simply physical paramteres of noise, are the determinants of adverse aftereffects of noise exposure. Further evidence suggests possible mechanisms for the ameliorative effects of perceived control. It is considered that while man adapts to unpredictable stressors, behavioral residues occur that are inimical to his subsequent functioning. There is a "psychic cost" for exposure to unpredictable and uncontrollable aversive events in spite of the facts that individuals seem able to adapt to a variety of stressors.

Green, Russell G., Powers, Patrick , C. Shock and noise as instigating stimuli in human aggression. Psychological Reports, 1971, 28(3), 983-986.

In two separate experiments, with 15 male undergraduates each, Ss were either attacked or not attacked by a confederate (C), with shocks or loud noises. In each case, S was later allowed to reply in kind to C. Ss attacked with shocks retaliated with both a greater number and greater intensities of shock than Ss not attacked. Ss attacked with loud noise retaliated more than nonattacked Ss only in terms of the number of noise bursts given. It is concluded that shock is a more reliable instigator of retaliatory aggression than aversive noise.

Katz, Roger C. Interactions between the facilitative and inhibitory effects of a punishing stimulus in the control of children's hitting behavior. Child Development, 1971, 42(5), 1433-1446.

The effects of a response-produced intense-noise stimulus (punishment) on the extinction of hitting behavior were investigated in 40 male first graders. The noise stimulus appeared to possess sufficient aversive properties to attenuate the level of responding during extinction. Ss who first received noise in extinction emitted significantly fewer hitting responses than Ss with no exposure to noise in either acquisition or extinction . Conversely, Ss who received noise with reinforcement in acquisition, followed by noise in extinction, showed greater resistance to extinction than *S*s with no exposure to noise. Results suggest that the differential effects of the punishing stimulus on responding in extinction were determined by its previous association with positively reinforcing events. Implications for previously reported punishment research are briefly discussed.

Nemecek, Jan; Grandjean, Etienne. Results of an ergonomic investigation of large-space offices. *Human Factors*, 1973, 15(3), 111-124.

Ergonomic measurements of noise, lighting, and room climate were performed in 15 large-space Swiss offices. Simultaneously, 519 employees were given a questionnaire about working in such offices (continuation of work, distractions, disturbances, interpersonal relations, and communications). Correlations among measures indicated factors that have special influence on the judgements of the large space office. Results form an objective, usable decision base for the selection and planning of an office building.

Sidorova, A.V. On the character of noise in day nursery groups. *Pediatriya*. 1970,49(1),67-70.

This research attempted to determine the factors affecting the noise level in the day nursery, and the noise level in the day nursery for children of different ages and at different intervals of time. There is no doubt that degree of excitation in children and their behavior are a direct function of noise level in the group.

Stoller, Alan. Urbanization and mental health. *Medical Journal of Australia*,1969, 2(5), 223-228.

Australian data was examined and compared with American studies on advancing industrialization and mental health. Pathological results often cited of urbanization, besides mental illness, are juvenile delinquency, suicide, marital breakdowns, illegitimate births and extranuptial conceptions, alcoholism, crime, and increasing road accidents. The effect of noise on mental health is also discussed.

Evidence shows that ". . . there is no clear evidence that mental disorders are increasing with high-density urbanization; in fact, there is evidence to show that there is, with advancing medical progress, an actual decrease in certain types of disorders".

TEXTS, BIBLIOGRAPHIES AND LITERATURE REVIEWS

During the period covered by this bibliography, a number of texts bibliographies, literature reviews and symposia have been generated dealing with noise as a general environmental pollutant or with specific noise sources. Williams, Layman, Karp & Wilson (1973) survey the literature on the relationship between mental health and noise. Shih's (1971) literature survey covers the present status of noise pollution, its sources, effects and control. A series of reports available from the Defense Documentation Center are particularly noteworthy. These consist of volumes dealing with gunfire noise, airplane noise, and sonic boom effects. Also available is a two volume work on the noise effects on human performance. Welch and Welch (1970) have produced a text on the physiological effects of noise with data from both human and infra human research in a wide range of areas including endocrine, cardiovascular and reproductive effects. A well conceived and written volume by Glass, Singer and Jerome (1972) contains the results of a series of experiments dealing with noise and other social stressors. Also available is Hodge and Garinther's (1973), Bioastonautics Data Book. This summary deals with the noise and blast environment, effects on performance and the auditory and non-auditory effects.

Chalupnik, James D. Transportation noises: A symposium on acceptability criteria. U. *Washington Press*, 1970, xiii, 350 pages.

Proceedings of a symposium sponsored by the Office of Noise Abatement of the Department of Transportation are presented. Articles by various authors include discussions of (a) transportation noise sources, (b) scales for expressing noise level, (c) laboratory methods for evaluating community response to noise, and (e) relation between laboratory results and community response.

Confer, Violet J. & Ashley, Thelma M. Noise and blast; An annotated bibliography of research performed at the human engineering laboratories. Human Engineering Labs Aberdeen Proving Ground Md., 1971, Report for 1956-1970.

The bibliography is an annotated compilation of 70 formally published reports dealing with noise and blast.

Environmental Pollution: Noise Pollution-Noise Effects on Human Performance. Defense Documentation Center Alexandria Va., 1971, Report No. DDC-TAS-71-39-1.

This is Volume I of two volumes on environmental pollution: noise pollution - noise effects on human performance in a series of annotated bibliographies on environmental pollution. Noise effects on humans such as motor reactions, hearings, speech, sleep, perception, nervous system, visual signals and fatigue are presented.

Environmental Pollution; Noise Pollution - Airplane Noise. Defense Documentation Center Alexandria Va., 1971, Report No. DDC-TAS-71-26-1.

The annotated bibliography is an unclassified compilation of references on airplane noise pollution in a series of bibliographies on environmental pollution. References deal primarily with effects on noise exposure on hearing, speech, communications and community/airport noise.

Environmental Pollution; Noise Pollution - Sonic Boom. Defense Documentation Center Alexandria Va., 1973, Report No. DDC-TAS-73-74.

The references in the bibliography cover a wide range of the parameter of sonic boom and noise pollution, as well as damages caused by it.

Environmental Pollution; Noise Pollution - Noise Effects on Human Performance. Defense Documentation Center Alexandria Va., 1973, DDC-TAS-73-69.

The bibliography is comprised of 111 citations of unclassified reports dealing with environmental pollution: Noise pollution - noise effects on human performance in a series of bibliographies on environmental pollution. References deal primarily with effects of noise exposure on hearing, speech, communications and community/airport noise.

Environmental Pollution (Noise Pollution - Gunfire Noise). *Defense Documentation Center Alexandria Va.*, 1974, Report No. DDC-TAS-74-11.

The bibliography is a collection of 42 references on environmental pollution (noise pollution - gunfire noise) such as auditory tests from exposure to various weapon sounds. The test also analyzes projectiles and their potential damage to hearing and the use of ear plugs to reduce the possibility of hearing loss from gun noise.

Environmental Protection Agency. *Proceedings of the International Congress on Noise as a Public Health Problem*, Ward, W.D. (Ed.) Document No. 550/9-73-008, Washington, D.C., 1973.

These proceedings represent world wide contributions to the congress on research results in the areas of hearing loss, performance and behavior, non-auditory reactions to noise, sleep disturbance and community response to noise exposure.

Environmental Protection Agency. *Public Health and Welfare Criteria for Noise*, Washington, D.C. 1973.

This document was published in response to the Noise Control Act of 1972. The criteria were designed to reflect the scientific knowledge most useful in indicating the kind and extent of all identifiable effects of noise on the public health. This document contains a comprehensive summary of research results dealing with noise exposure, noise rating schemes, annoyance, noise induced hearing loss, masking and physiological effects.

Environmental Protection Agency. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, Document No. 550/9-74-004. Washington, D.C., 1974.

This report is a follow on to the EPA Noise Criteria document, (EPA, 1973). The document identifies maximum exposure levels, to avoid significant adverse effects from environmental noise and both infra and ultra sound.

Glass, David C. & Singer, Jerome E. Urban Stress. Experiments on Noise and Social Stressors, New York, N. Y. Academic Press, 1972.

This volume deals with the conduct and results of some two-dozen research projects using urban noise as a stressor. Experiments are roughly trichotomized as; those which deal with the direct effects of stress, adaptation to stress and the adverse after-effects of stress. With respect to the direct effects of noise, the researchers indicate their data show:

1. Noise does not affect task performance or psychophysiological reaction.

2. Especially aversive noise does not prevent behavioral and autonomic adaptation.

3. Performance decrements seem to occur only for highly complex tasks or vigilance tasks.

After effects include lowering of frustration tolerance following unsignaled noise. Additionally , quality of proofreading performance, and ability to resolve response competition were also impaired following noise exposure.

Grether, W.F. Noise and human performance. USAF AMRL Technical Report, 1971, 70-29, 48 pgs.

The possible effects of noise on human performance have been the subject of considerable research dating back to 1916. This interest has been stimulated by concern about noise in factories, offices, schools, aircraft, and other military vehicles. Two very direct and harmful effects of noise, permanent hearing loss and auditory masking, are briefly reviewed. The nonauditory effects on performance measures e.g., RT, vigilance, time estimation, tracking, manual manipulation, intellect-research data on noise and human performance appear rather contradictory and inconsistant. While many studies have found no performance impairment, and even improvement, there are some types of measures that rather consistently show decrements from exposure to noise. Some theoretical explanatory mechanisms to account for effects of noise on performance are included.

Guignard, J.C. A basis for limiting noise exposure for hearing conversation. *Dayton University Ohio Research Institute,* 1973, Report No. UDRI-TR-73-29.

A compilation of data is provided, with references to published work, which represents the present state of knowledge concerning the effects of continuous and impulsive noise on hearing. The danger to the ear of both occupational and nonoccupational human exposure to noise is considered. Data are included or cited which enable quantitative predictions to be made of the risk to hearing in the American population due to noise exposure in any working or living context. Recommendations are made concerning the need to obtain more definitive data. Relevant aspects of noise effects on the ear are discussed in appendices to the main report.

Hodge, David C. & Garinther, George K. Noise and blast. *Bioastronautics Data Book, Wash.,DC NASA Scientific and Technical Information Office,* 1973, VIII, 930 pgs.

The noise and blast environment, techniques of noise measurement, and the effects of noise on hearing sensitivity and performance are described. Community response to noise exposure, physiological (i.e. nonauditory) effects of noise exposure, and methods for minimizing the detrimental effects of noise on hearing and communication are also considered.

Holding D. H. Experimental psychology in industry: Selected reading. *Baltimore Md.: Penguin Books,* 1969, 445 pgs.

This work contains a collection of papers by various authors on man-machine interactions, covering a broad range of human performance topics including human engineering, noise abatement, and quality control.

Kryter, Karl D.; Jansen, Gerd; Parker, Donald; Parrack, Horace O. & Thiessen, George. Non-auditory effects of noise. National Academy of Sciences-National Research Council Washington D.C. Comm on Hearing Bioacoustics and Biomechanics, 1971, 31 pages.

The report is a summary and evaluation of research findings that relate to any effects of noise other than to the ear and related structures. For example, included herein are research efforts concerned with psychological effects of noise, effects on task performance, effects on the cardiovascular system, and on general health. This report also presents areas and types of research studies that may help to provide full answers to questions on the degree of noise control desirable with respect to the non-auditory effects of noise normally present in living and working environments.

Mangano, M.G. Some consideration on the biological effects of noise in modern civilization. Difeso Sociale, 1970, 47(3), 167-68.

On the basis of a review of the literature on the biological psychological, and social effects of noxious auditory stimuli, various corrective ways and means are suggested.

Nixon, Charles W. Some effects of noise on man. Aerospace Medical Research Lab, Wright Patterson AFB Ohio, 1971, Report No. AMRL-TR-71-63.

The primary reason for noise abatement is to eliminate deleterious effects on man. Consequently, it is important that personnel who implement noise control measures understand what human responses are to be expected when man experiences various categories of noise exposure. It is the intent of this paper, through citing of laboratory experimentation and noise exposure experience over the years, to demonstrate that there are types of acoustic exposures which do affect the physiological and psychological functions of man in different ways.

Shih, H. H. A literature survey of noise pollution. Catholic University of America Washington, D.C. Institute of Ocean Science and Engineering, 1971, Report No. 71-5.

Physically, noise is a complex sound that has little or no periodicity.

However, the essential characteristic of noise is its undesirability. Thus, noise can be defined as any annoying or unwanted sound. In recent years, the rapid increase of noise level in our environment has become a national public health hazard. Noise affects man's state of mental, physical, and social well-being. The problem forms a special type of air pollution. Noise study is a rather new subject among other branches of science. The transition from art to near-science started from before World War II. The work is an attempt to arrive at an understanding of the general situation on the problem of noise. The survey consists of four major parts: The present status of noise pollution, its sources, its effects, and the control. Many urgent research needs are also identified.

Welch, Bruce L. & Welch, Annemarie S. (Eds.) Physiological effects of noise. New York, N.Y. Plenum Press, 1970.

Papers presented in this volume represent the content of a 1969 symposium devoted to the physiological effects of audible sound. Contributions represent the efforts of scientists from the western hemisphere and both eastern and western Europe. Papers are presented based on both human and infra-human data in the areas of: Adaptation, Disease resistance; Endocrine and metabolic function; Cardiovascular and reproductive effects; Neurological, biochemical and pharmacological effects; Sleep and sonic boom studies.

Williams, John S.,Leyman, Edward; Karp, Stephen A. & Wilson, Paul T. Environment pollution and mental health. Washington D.C.: Information Resources Press. 1973,XI,136pgs.

Recent research on the relationship between mental health and environmental pollutants, noise, housing, and recreation is surveyed. Methodological implications and neglected research areas are discussed.